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Energy and U. S. Agriculture: Irrigation Pumping, 1974

Gordon Sloggett

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ABSTRACT

In 1974, U.S. farmers irrigated over 35 million acres with water pumped from wells and from rivers and lakes. About 260 trillion Btus of energy costing \$594 million were required to pump the water. Electricity was used to pump water on 15.6 million acres followed by natural gas, 10.6 million; diesel, 3.9 million; LPG, 3.3 million; and gasoline, 1.5 million acres.

ACKNOWLEDGMENTS

The author wishes to thank the irrigation experts in each of the States who provided valuable data needed to make the many estimates for this work. Earle Gavett, Economic Research Service, also provided valuable assistance during the course of this work. The author takes responsibility for the final estimates.

These estimates were prepared by the Economic Research Service, U.S. Dept. of Agriculture, Washington, D.C. under a jointly sponsored interagency agreement with the Federal Energy Administration.

HIGHLIGHTS

U.S. farmers irrigated over 35 million acres in 1974 with 69 million acre-feet of water pumped from wells and surface water. Acres irrigated by type of energy used to pump the water were estimated at 15.6 million for electricity, 10.6 million for natural gas, 3.9 million for diesel, 3.3 million for LPG (liquid petroleum gas), and 1.5 million for gasoline.

Energy consumed was estimated at 19 billion kWh of electricity, 132 billion cubic feet of natural gas, 178 million gallons of diesel fuel, 237 million gallons of LPG, and 71 million gallons of gasoline. The combined direct energy in these fuels equals 260 trillion Btus (does not include the Btus required to generate the electricity), representing about 20 percent of all energy used on farms for production.

An estimated \$594 million was spent in 1974 for energy for onfarm pumping of irrigation water. The least expensive source of energy for pumping was natural gas followed by electricity, diesel, LPG, and gasoline.

Several factors affect energy used for pumping irrigation water, including acres irrigated, quantity of water applied, method used to apply the water, and height the water must be lifted. These factors explain State and regional differences in energy consumption.

Texas irrigates the most acres and spends more money on pumping irrigation water than any other State. California uses the most electricity among all States for irrigation energy while Texas uses the most natural gas; Nebraska is the largest user of diesel and LPG and Arkansas is the largest user of gasoline.

CONTENTS

	<u>Page</u>
INTRODUCTION	1
DATA SOURCES	3
PROCEDURE	6
RESULTS	6
APPENDIX I-PROCEDURE	35
APPENDIX II-IRRIGATION SPECIALISTS CONTACTED	37

TABLES

<u>Number</u>	<u>Title</u>	<u>Page</u>
1	Fuel requirements for pumping one acre-foot of water at one pound per square inch (PSI)	5
2	Acres irrigated and amount applied from onfarm pumped water, 1974	6
3	Acres irrigated with pumped water by type of fuel, 1974	7
4	Total energy requirements in units of fuel for onfarm pumping of irrigation water, 1974	8
5	Total energy requirements in Btus for onfarm pumping of irrigation water, 1974	8
6	Energy costs for onfarm pumping of irrigation water, 1974	8
7	Acres irrigated with pumped water by source of water, 1974	10
8	Feet of lift required for pumping and acre-feet of irrigation water applied, 1974	11
9	Quantity of water pumped onfarm for irrigation, 1974	12
10	Acres irrigated with pumped water by type of distribution system, 1974	13
11	Acres irrigated with pumped water by type of energy, 1974	15
12	Quantity of energy used in units of fuel for onfarm pumping of irrigation water, 1974	16
13	Quantity of energy used <u>per acre</u> in units of fuel for onfarm pumping of irrigation water, 1974	18-19
14	Quantity of energy used <u>per acre-foot</u> for onfarm pumping of irrigation water, 1974	20-21
15	Quantity of energy used in Btus for onfarm pumping of irrigation water, 1974	22-23
16	Quantity of energy used <u>per acre</u> in Btus for onfarm pumping of irrigation water, 1974	24-25

<u>Number</u>	<u>Title</u>	<u>Page</u>
17	Quantity of energy used <u>per acre-foot</u> in Btus for on-farm pumping of irrigation water, 1974	26-27
18	Total cost of energy for onfarm pumping of irrigation water, 1974	28-29
19	Cost <u>per acre</u> for onfarm pumping of irrigation water, 1974	30-31
20	Cost <u>per acre-foot</u> for onfarm pumping of irrigation water, 1974	32-33
21	Prices used for energy cost calculations	34

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INTRODUCTION

Land irrigated with pumped water represents over 10 percent of the Nation's harvested acres.^{1/} However, irrigated farms accounted for 25 percent of all 1969 farm sales in the United States.^{2/}

More than 35 million acres of U.S. farmland were irrigated in 1974 with the aid of energy-using pumps on farms and ranches. With the recent increase in energy prices and the awareness of shortages in fuel used for irrigation--especially natural gas--it is important to know the types, amounts, and State and regional use of energy consumed in irrigation.

This report estimates the amounts of different types of energy used for on-farm pumping and distribution of irrigation water. Energy used by irrigation organizations is not included.^{3/} These estimates are made for the entire country, farm production regions, and individual States, including Alaska and Hawaii (fig. 1).

To make the estimates of energy used, it was necessary to determine: (1) acres irrigated from groundwater and from pumped surface water, (2) feet of lift

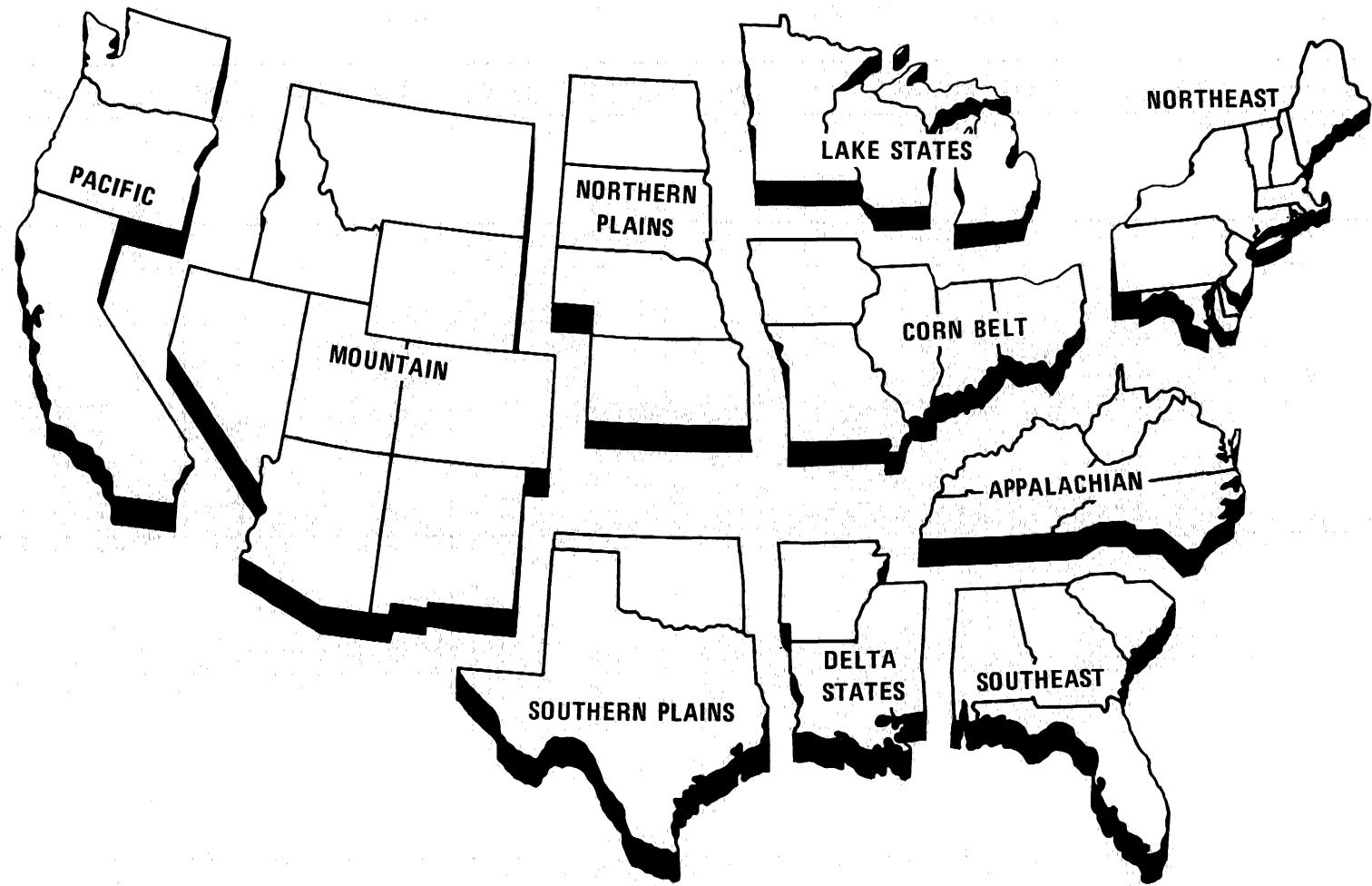
^{1/}"Estimated Changes in Cropland Acres and Use for 1975." Unpublished working material for Economic Research Service. This report shows 320 million harvested acres in 1974.

^{2/}1969 Census of Agriculture, Irrigation V. IV, U.S. Dept. of Commerce, Washington, D.C., p. 47.

^{3/}Energy used by irrigation organizations to deliver water to farms is not included in this report. The Bureau of Reclamation used an estimated 3.6 billion kWh to pump irrigation water in 1974. (Dan Dvonskin, Ken Nicol, and Earl Heady, "Energy Use for Irrigation in the Seventeen Western States," Center for Agricultural and Rural Development, Iowa State University, July 1975). This would be in addition to 19 billion kWh used for onfarm pumping of irrigation water in 1974 (table 5, p. 8).

Figure 1

FARM PRODUCTION REGIONS



required for groundwater and pumped surface water, (3) types of distribution systems used to apply water to fields, (4) types of power units used for pumping, and (5) acre-feet of water applied. These were all determined on a state-wide basis. Estimates of pumping unit efficiency and pressure to operate distribution systems were also obtained. These factors were determined and applied uniformly for all States.

DATA SOURCES

The many sources of information for this report ranged from U.S. Geological Survey publications to best estimates by irrigation experts.^{4/} Definitions and sources used are as follows:

Acres Irrigated from Groundwater

Water in aquifers is commonly referred to as groundwater and must be pumped from wells for irrigation. Several sources were used to make a 1974 estimate of acres irrigated from groundwater. Several States conduct surveys or have other procedures to estimate acres irrigated from groundwater. Where available, this estimate was used. Where not available, total acres irrigated in 1974 came from the 1974 Irrigation Survey in the Irrigation Journal. The proportion of acres irrigated from groundwater as published by the U.S. Geological Survey (USGS) was then multiplied by total acres irrigated to get an estimate of acres irrigated from groundwater.^{5/}

Acres Irrigated from Pumped Surface Water

Surface water is water in lakes, streams, or rivers. Some of this water is pumped onto fields for irrigation, but no source for data for acres irrigated in this manner was found. Therefore, irrigation experts in each State were asked to estimate how many acres were irrigated with water pumped from surface sources.

Feet of Lift

Feet of lift is the height the water must be raised from its source to the field for application. Persons knowledgeable of irrigation in each State were asked for a weighted statewide average feet of lift for irrigation wells in

^{4/} A list of irrigation experts contacted for State estimates appear on p. 37.

^{5/} C. Richard Murray and E. Bodette Reeves, Estimated Use of Water in the U.S. in 1970, USGS Circ. 676, U.S. Dept. Int., Geological Survey, Washington, D.C., 1972, pp. 22-23.

their State. They were also asked for a weighted average feet of lift for pumped surface water. The weight was approximate acres irrigated according to pumping depths.

Types of Distribution Systems and Types of Power Units

Major water distribution systems include various sprinkler and flooding methods to put water on fields. Power units considered were electric, diesel, gasoline, natural gas, and LPG. Information on numbers of distribution systems and types of power units in the 1974 Irrigation Survey in the Irrigation Journal were used where available.^{6/} When the information was not available, knowledgeable people in the States were asked for estimates.

Acre-Feet Applied

USGS data were used as an estimate of the quantity of water applied per acre and irrigation experts in each State were asked to review the estimates.^{7/} Several experts offered alternative estimates and, in some instances, USGS data were modified.

Pumping Unit Efficiency

A new irrigation pump has an efficiency of about 75 percent (efficiency is a measure of energy input to water output). Efficiency declines as wear occurs. In several States having significant amounts of groundwater, irrigation engineers were asked to estimate average operational pump efficiency. Since their estimates varied, coefficients for three pump efficiency ratings were used to provide three estimates of energy consumption (table 1). Power units operating the pumps were assumed to be in average condition.

All energy estimates in this report assume a 60-percent water pump efficiency and power units in average operating condition. Estimates of energy

^{6/} To estimate area irrigated by type of energy, it was necessary to assume that each type of power unit pumped an equal amount of water. However, in States where natural gas is used extensively, those wells typically irrigate more acreage than non-natural gas-powered wells. Therefore, the following adjustments were made. It was assumed that: natural gas supplied 35 percent of the acres irrigated in Arizona and that each natural gas-powered well irrigated 200 acres in Kansas, 120 acres in Texas and New Mexico, and 150 acres in Oklahoma. The remaining acreage in those States was then divided proportionately with Irrigation Journal figures.

^{7/} Murray and Reeves, op. cit.

consumption for 55-percent pump efficiency may be determined by increasing the 60-percent estimates by 7.62 percent. Estimates for 65-percent efficiency can be estimated by decreasing the 60-percent estimates by 7.63 percent. All of the energy estimates in this report may be adjusted similarly.

Table 1--Fuel requirements for pumping one acre-foot of water at one pound per square inch (PSI)

Fuel	Unit	Percent efficiency		
		65	60	55
		<u>Unit fuel/ac. ft./PSI</u> ^{1/}		
Diesel	Gal.	.4000	.4330	.4659
Gasoline	do.	.5004	.5417	.5830
LPG	do.	.6254	.6771	.7287
Natural gas	MCF ^{2/}	.0625	.06771	.07287
Electricity	kWh	4.8544	5.2595	5.6603

^{1/} PSI equals pounds per square inch.

^{2/} MCF equals 1,000 cubic feet.

Source: Material provided by Delbert Schwab, agricultural engineer, Oklahoma State University.

Distribution System Pressure Requirements

State engineers were also asked for PSI requirements for various irrigation distribution systems. The estimates were varied, so a middle range was selected.

Type of System	PSI
Big gun	165
Center pivot	100
Other sprinkler	70
Surface distribution	5

The estimates include the pressure required to overcome friction loss in lines from the pump through the distribution system and to apply water to the land. The pressure required to operate the system is in addition to that needed to get the water to ground level.

PROCEDURE

All of the preceding data were required for estimating energy requirements for onfarm pumping of irrigation water. Basically, the procedure (shown in app. I) estimates how much water is pumped for irrigation in each State. It then estimates volume, type, and cost of energy required to pump and distribute that quantity of water. It does this for different energy sources separately for groundwater and pumped surface water.

After the initial energy estimates were derived, they were reviewed by State irrigation specialists (app. II). Revisions they made were incorporated into this report. It should be emphasized that these results are based on estimates of statewide averages and that they may or may not apply to specific crops in specific areas.

RESULTS

Study results are presented as summaries for the Nation and for States and regions. Energy estimates are made on the basis of number of acres irrigated with pumped water and the quantity of water pumped. After reviewing estimates of acres irrigated reported in the Statistical Reporting Service 1975 June enumerative survey,^{8/} the author felt that the estimates given by irrigation experts in the States tended to be on the maximum side of a reasonable range of estimated acres irrigated. Thus, there may be fewer acres than those cited in table 2. Therefore, the energy estimates may also be overstated. No statistical procedure is available to determine the accuracy of these estimates.

Table 2--Acres irrigated and amount applied from onfarm pumped water, 1974

Type of water :	Area irrigated		Amount applied	
:	<u>1,000 acres</u>	<u>Percent</u>	<u>1,000 acre-feet</u>	<u>Percent</u>
Groundwater :				
	25,997	74	51,530	75
Pumped surface water :				
	7,356	21	14,101	21
Both :				
	1,729	5	3,266	4
Total :	35,082	100	68,899	100

^{8/} 1975 June Enumerative Survey, Stat. Rpt. Serv., U.S. Dept. Agr., Washington, D.C.

U.S. Summary

Groundwater was the major source of pumped irrigation water in 1974 (table 2). Nearly all groundwater requires pumping, and part of the surface water used for irrigation must also be pumped. Electricity and natural gas were the most popular sources of pumping energy (table 3).

Table 3--Acres irrigated with pumped water by type of fuel, 1974

Energy	:	Groundwater	:	Pumped surface water	:	Total	:	Proportion of all energy types
:----- <u>1,000 acres</u> -----								
Electricity	:	11,721		3,900		15,621		44.5
Diesel	:	2,693		1,242		3,935		11.2
Gasoline	:	1,025		523		1,548		4.4
Natural gas	:	9,687		948		10,635		30.4
LPG	:	2,585		753		3,338		9.5
Total	:	27,711		7,366		<u>1/</u> 35,077		100.0
Percent	:	79		21				

1/ Includes 1,729,000 acres irrigated by both groundwater and surface water.

Quantities of energy used in units of fuel and Btus are shown in tables 4 and 5. At 261 trillion Btus, pumping water for irrigation would account for 20 percent of the 1,298 trillion Btu total energy used for onfarm production in 1974.9/

Electricity pumped water of 44.5 percent of the area irrigated (table 3), but it only consumed 25.2 percent of the total Btus used for irrigation (table 5). This does not include the Btus used to generate electricity. However, about 90 percent of the electricity used for irrigation in the United States was in the Pacific and Mountain regions (table 12). Hydropower, which does not require fossil energy, was used to generate 32 percent of the electricity in the Mountain region and 59 percent in the Pacific region.10/ It is not known how much of the electricity generated by non-Btu using hydroelectric plants was used for irrigation. Therefore, Btus used to generate electricity were not computed.

9/ "Energy and U.S. Agriculture: 1974 Data Base." Office of Energy Conservation and Environment, FEA and Economic Research Service, USDA, Vol. 1. Sept. 1976.

10/ Lulie Crump and C.L. Reading, Fuel and Energy Data: United States, by States and Regions, 1972, Bur. Mines Circ. 1974, U.S. Dept. Int., Washington, D.C.

Groundwater pumping represented 87.2 percent of the total \$594 million energy cost for onfarm irrigation water pumping in 1974 (table 6). ^{11/} But it accounted for only about 80 percent of the acreage irrigated (table 7). This is because of the higher cost per acre for pumping groundwater relative to pumping surface water. These figures are only for energy and do not include any irrigation equipment or maintenance costs.

Table 4--Total energy requirements in units of fuel for onfarm pumping of irrigation water, 1974

Energy	Unit	Groundwater	Surface water	Total U.S.
Electricity	Bil. kWh	14	5	19
Diesel	Mil. gal.	160	18	178
Gasoline	do.	59	12	71
Natural gas	Mil. MCF	128	4	132
LPG	Mil. gal.	216	21	237

Table 5--Total energy requirements in Btus for onfarm pumping of irrigation water, 1974

Energy	Groundwater	Surface water	Total U.S.	
			Billion Btus ^{1/}	Percent
Electricity	48,580	17,028	65,607	25.2
Diesel	22,342	2,471	24,813	9.5
Gasoline	7,379	1,451	8,830	3.4
Natural gas	135,098	3,857	138,955	53.3
LPG	20,496	1,967	22,463	8.6
Total	233,895	26,773	260,668	100.0

^{1/} Btu conversion factors are: electricity, 3,413 per kWh; diesel, 140,000 per gal.; gasoline, 125,000 per gal.; natural gas, 1,050,000 per MCF; LPG, 95,000 per gal.

Table 6--Energy costs for onfarm pumping of irrigation water, 1974^{1/}

Energy	Groundwater	Surface water	Total	
			Million dollars	Percent
Electricity	277	54	331	55.9
Diesel	57	7	64	10.8
Gasoline	27	6	33	5.5
Natural gas	96	3	99	16.2
LPG	61	6	67	11.2
Total or percent	518	76	594	100.0

^{1/} Does not include ownership costs or operating costs other than fuel.

11/ Prices used are shown in table 21.

State and Regional Summary

Energy used for irrigation varies by the number of acres irrigated, quantity of water pumped for irrigation (acres irrigated and acre-feet applied), water lifting height, and the amount of pressure required to operate the various irrigation distribution systems. Tables 7,8,9, and 10 show how these factors vary among States and cause differences in energy used between States. Texas, California, and Nebraska, for example, are large energy users due to the very large areas irrigated (table 7).

In areas where water is pumped from deep wells--Hawaii, Arizona, New Mexico, Idaho, Washington, and others--energy use will be high (table 8).^{12/} When the lift is high and water applications are heavy, energy use increases significantly; Hawaii, Washington, Arizona, and New Mexico are examples. The high lift for surface water from rivers in Washington and Oregon add even more to the energy use associated with irrigation.

Quantity of water pumped affects energy used and is related to acres irrigated and acre-feet applied (table 9). States in the Pacific and Mountain regions, which have large irrigated acreage and high acre-feet requirements, pump large quantities of water for irrigation, almost 35 million acre-feet combined. The Southern and Northern Plains also pump large quantities of water but that is due mainly to large acreages irrigated, rather than high acre-feet requirements. California farmers pump more water than farmers in any other State, followed by Texas and Nebraska.

Another factor affecting energy used for irrigation is the distribution system used to apply water (table 10). A big gun system is a rather large sprinkler that emits large amounts of water covering an acre or more at a setting. It is usually mounted on wheels and is moved either by hand or automatically across a field. A center pivot system is a line of pipe on wheels with numerous smaller sprinklers along the pipe which is fixed at one end. The pipe automatically pivots about the fixed end and usually irrigates about a 130-acre circle. Other sprinklers are side roll, skid, and hand move, but usually not automatically moved. Most surface distribution is accomplished by pipes with holes that let water run onto the field or by siphoning water from irrigation ditches with siphon tubes.

The amount of energy needed to operate the various types of distribution systems is proportional to the amount of pressure each system requires (big gun, 165 PSI; center pivot, 100 PSI; surface distribution, 5 PSI). Big guns require the largest amount of energy; surface distribution needs the least. However, energy consumption is not the only factor the farmer must consider in selecting a distribution system. More important factors are terrain, soil type, and type of crop irrigated. Surface distribution is not practical on either sandy soil

^{12/}This is the pumping depth (feet of lift) of the wells, not how deep the wells are drilled.

Table 7--Acres irrigated with pumped water by source of water, 1974

State and region	Groundwater	Surface water	Both	Total
1,000 acres				
Northeast:	137	155		292
Maine	0	7		7
Massachusetts	1	31		32
New Hampshire	0	6		6
Vermont	0	2		2
Rhode Island	0	3		3
Connecticut	1	8		9
New York	30	29		59
New Jersey	75	30		105
Pennsylvania	2	17		19
Delaware	20	6		26
Maryland	8	16		24
Lake States:	253	158		411
Michigan	56	53		109
Wisconsin	115	55		170
Minnesota	82	50		132
Corn Belt:	274	96		370
Ohio	12	20		32
Indiana	19	14		33
Illinois	50	0		50
Iowa	50	7		57
Missouri	143	55		198
Northern Plains:	6,380	684	186	7,250
North Dakota	33	23		56
South Dakota	43	91		134
Nebraska	4,074	505	176	4,755
Kansas	2,230	65	10	2,305
Appalachian:	17	175		192
Virginia	5	31		36
West Virginia	0	3		3
North Carolina	5	104		109
Kentucky	1	26		27
Tennessee	6	11		17
Southeast:	1,058	980	3	2,041
South Carolina	10	26	3	39
Georgia	80	114		194
Florida	960	823		1,783
Alabama	8	17		25
Delta States:	1,966	722		2,688
Mississippi	226	94		320
Arkansas	1,400	296		1,696
Louisiana	340	332		672
Southern Plains:	7,770	1,491	256	9,517
Oklahoma	680	40		720
Texas	7,090	1,451	256	8,797
Mountain:	3,431	881	1,284	5,595
Montana	40	284		324
Idaho	850	302		1,152
Wyoming	125	50	50	225
Colorado	900	45	700	1,645
New Mexico	634	43	143	820
Arizona	552	0	391	943
Utah	160	122		282
Nevada	170	34		204
Pacific:	4,638	2,004		6,642
Washington	200	1,068		1,268
Oregon	188	575		763
California	4,250	361		4,611
Alaska	3	4		7
Hawaii	70	6		76
Total	25,997	7,356	1,729	35,081

Table 8--Feet of lift required for pumping and acre-feet of irrigation water applied, 1974^{1/}

State and region	Groundwater	Surface water	Acre-feet applied
<u>--Feet of lift--</u>			
Northeast :			
Maine	0	15	0.42
Massachusetts	80	10	0.42
New Hampshire	0	20	0.42
Vermont	0	20	0.42
Rhode Island	0	20	0.42
Connecticut	80	20	0.42
New York	80	25	0.42
New Jersey	175	20	0.83
Pennsylvania	150	35	0.42
Delaware	50	20	0.58
Maryland	50	20	0.75
Lake States :			
Michigan	100	20	0.67
Wisconsin	45	20	0.83
Minnesota	60	10	0.75
Corn Belt :			
Ohio	100	25	0.50
Indiana	150	25	0.83
Illinois	30	0	0.00
Iowa	35	25	0.58
Missouri	75	25	0.50
Northern Plains :			
North Dakota	75	35	1.00
South Dakota	70	150	1.25
Nebraska	100	20	1.83
Kansas	180	15	1.50
Appalachian :			
Virginia	30	25	0.50
West Virginia	0	25	0.58
North Carolina	150	35	0.50
Kentucky	75	25	0.33
Tennessee	100	25	0.58
Southeast:			
South Carolina	300	20	0.68
Georgia	250	15	0.58
Florida	85	5	0.75
Alabama	150	15	0.33
Delta States :			
Mississippi	110	15	1.58
Arkansas	45	15	1.83
Louisiana	100	10	1.83
Southern Plains :			
Oklahoma	250	20	1.33
Texas	200	40	1.50
Mountain :			
Montana	100	60	2.70
Idaho	275	0	2.50
Wyoming	150	25	1.83
Colorado	115	10	1.08
New Mexico	350	5	2.50
Arizona	350	0	5.50
Utah	225	10	3.00
Nevada	250	20	3.00
Pacific :			
Washington	250	250	3.80
Oregon	200	150	2.83
California	110	10	3.17
Alaska	100	10	0.25
Hawaii	700	10	6.00

1/

Estimated statewide average weighted by number of wells at each depth.

Table 9--Quantity of water pumped onfarm for irrigation, 1974

State and region	Groundwater	Surface water ^{1/}	Total
		1,000 acre-feet	
<u>1,000 acre-feet</u>			
Northeast:			
Maine	94.31	83.84	178.15
Massachusetts	0.00	2.89	2.89
New Hampshire	0.42	13.21	13.63
Vermont	0.00	2.48	2.48
Rhode Island	0.00	0.83	0.83
Connecticut	0.42	1.24	1.24
New York	12.51	3.30	3.72
New Jersey	62.47	11.97	24.48
Pennsylvania	0.83	25.56	112.51
Delaware	11.66	7.02	7.85
Maryland	6.00	3.46	15.12
		11.88	17.88
Lake States:	194.65	118.51	313.16
Michigan	37.35	35.48	72.83
Wisconsin	95.79	45.90	141.69
Minnesota	61.50	37.13	98.63
Corn Belt:	155.83	53.42	209.25
Ohio	6.00	9.80	15.80
Indiana	15.83	11.87	27.70
Illinois	33.35	0.00	33.35
Iowa	29.15	4.37	33.52
Missouri	71.50	27.38	98.88
Northern Plains:	11,237.00	1,160.80	12,397.80
North Dakota	33.00	22.50	55.50
South Dakota	53.75	113.29	167.04
Nebraska	7,790.25	926.76	8,717.01
Kansas	3,360.00	98.25	3,458.25
Appalachian:	8.83	84.47	93.30
Virginia	2.50	15.84	18.34
West Virginia	0.00	1.73	1.73
North Carolina	2.50	51.97	77.04
Kentucky	0.33	8.57	8.90
Tennessee	3.50	6.35	9.85
Southeast:	777.97	706.90	1,484.87
South Carolina	8.67	17.87	26.54
Georgia	46.64	65.80	112.44
Florida	720.00	617.62	1,337.62
Alabama	2.66	5.60	8.26
Delta States:	3,547.18	1,300.48	4,847.66
Mississippi	357.76	148.17	505.93
Arkansas	2,566.20	542.59	3,108.79
Louisiana	623.22	609.73	1,232.95
Southern Plains:	11,925.44	2,230.24	14,155.86
Oklahoma	906.44	53.03	959.47
Texas	11,019.00	2,177.40	13,196.40
Mountain:	10,961.62	2,240.33	13,201.95
Montana	80.00	769.04	849.04
Idaho	2,122.32	754.55	2,876.87
Wyoming	320.77	92.00	412.77
Colorado	1,732.80	48.52	1,781.32
New Mexico	1,943.74	107.00	2,050.74
Arizona	3,772.00	0.00	3,772.00
Utah	480.00	366.00	846.00
Nevada	510.00	103.23	613.23
Pacific:	14,752.35	6,829.88	21,582.23
Washington	760.00	4,057.71	4,817.71
Oregon	532.60	1,629.77	2,162.37
California	13,459.75	1,142.00	14,602.15
Alaska	0.75	0.25	1.00
Hawaii	420.00	14.10	434.10
Total	54,075.93	14,823.40	68,899.33

^{1/}Includes only 7,346,000 acres irrigated by pumped surface water.

Table 10--Acres irrigated with pumped water by type of distribution system, 1974^{1/}

State and region	Big gun	Center pivot	Other sprinkler	Surface
1,000 acres				
Northeast:				
Maine	19.24	17.99	249.56	5.63
Massachusetts	0.00	0.07	6.86	0.00
New Hampshire	0.00	0.32	32.03	0.34
Vermont	0.00	0.06	5.88	0.00
Rhode Island	0.00	0.02	1.96	0.00
Connecticut	0.00	0.03	2.94	0.00
New York	8.22	0.00	50.49	0.00
New Jersey	0.00	5.28	95.12	5.28
Pennsylvania	2.82	0.00	16.01	0.00
Delaware	7.00	8.56	10.38	0.00
Maryland	1.19	3.58	19.07	0.00
Lake States:	49.16	209.41	127.15	26.73
Michigan	10.92	62.24	36.04	0.00
Wisconsin	13.61	78.20	79.95	0.00
Minnesota	24.63	68.97	11.17	26.73
Corn Belt:	47.02	70.18	64.91	187.99
Ohio	4.74	4.74	22.12	0.00
Indiana	2.66	11.97	11.30	7.31
Illinois	10.00	25.00	14.00	1.00
Iowa	8.62	7.47	12.65	28.75
Missouri	20.99	20.99	4.84	150.93
Northern Plains:	60.31	1,536.07	580.12	5,073.73
North Dakota	3.30	26.40	1.87	23.92
South Dakota	11.55	34.65	65.29	22.13
Nebraska	0.00	1,025.06	467.50	3,263.04
Kansas	45.45	449.96	45.45	1,764.62
Appalachian:	8.61	8.06	161.76	13.80
Virginia	6.97	0.00	29.66	0.05
West Virginia	0.00	0.00	2.94	0.03
North Carolina	0.00	6.54	91.52	10.89
Kentucky	0.00	0.00	26.47	0.27
Tennessee	1.64	1.52	11.17	2.56
Southeast:	321.50	63.73	488.85	1,166.51
South Carolina	8.67	0.00	29.29	1.45
Georgia	0.00	38.57	154.29	0.00
Florida	307.20	19.20	292.27	1,164.82
Alabama	5.63	5.96	13.00	0.24
Delta States:	19.66	24.88	60.10	2,583.61
Mississippi	2.26	4.52	5.46	307.36
Arkansas	14.00	16.96	47.92	1,672.13
Louisiana	3.40	3.40	6.73	659.11
Southern Plains:	108.38	521.48	1,766.17	7,121.34
Oklahoma	20.40	81.60	270.58	347.20
Texas	87.98	439.88	1,495.59	6,774.15
Mountain:	9.26	784.59	623.08	4,179.84
Montana	0.80	23.39	54.48	246.15
Idaho	0.00	34.57	253.48	864.15
Wyoming	0.00	7.50	88.00	66.69
Colorado	0.00	353.34	64.45	1,227.01
New Mexico	0.00	233.25	15.98	571.07
Arizona	0.00	28.29	37.72	876.99
Utah	8.46	31.02	98.70	143.82
Nevada	0.00	10.22	10.22	184.57
Pacific:	0.00	395.74	1,668.57	4,577.51
Washington	0.00	342.31	190.17	735.34
Oregon	0.00	53.43	694.58	15.27
California	0.00	0.00	783.81	3,829.61
Alaska	0.00	0.80	3.19	0.00
Hawaii	0.00	0.00	14.00	56.00
Total	643.12	3,633.93	5,807.42	24,992.56
Percent	2.00	10.00	17.00	71.01

^{1/}Include only acres irrigated with pumped water.

or rolling ground. Factors considered in selecting a particular sprinkler system are labor availability, field size, and crops, among others.

Surface distribution represented the largest area irrigated with pumped water, followed by other sprinkler systems, center pivots, and big guns (table 10). Center pivot acreage is increasing rapidly due to the high cost and shortage of labor and the fact that water is available on rolling land not practical to irrigate in any other manner.^{13/} States with large acreages of center pivot distribution in 1974 were Nebraska, Kansas, Colorado, Texas, New Mexico, and Washington.

Electricity led all other energy sources in total acres irrigated, followed by natural gas, diesel, LPG, and gasoline (table 11). However, there were significant differences in the types of energy use within and among States and regions. The Pacific region was almost totally electric for pumping irrigation water. However, a large part of the acreage irrigated in Texas, New Mexico, Oklahoma, and Kansas used natural gas for energy. The above two conditions were the result of an abundant local supply of relatively low-cost electricity and natural gas. Although low-cost energy is important, a farmer's selection of a power unit also depends on availability of energy, size of power unit needed, reliability of the power unit, maintenance cost, convenience of operation, and investment cost.

Consumption and Cost of Energy

State data on consumption and cost of energy used for onfarm pumping are detailed in tables 12-20. Quantities of energy consumed by State in units of fuel are shown in tables 12, 13, and 14. In all States, less energy is used for pumping surface water than groundwater. Among States, California used the most electricity for irrigation, Nebraska used the most LPG, Arkansas topped all others in gasoline, and Texas ranked highest in natural gas consumption.

The largest user of energy for pumping irrigation water measured in Btus was Texas, followed by Nebraska, Kansas, Arkansas, and New Mexico (tables 15, 16, and 17). Per acre, the high energy users were States in the Mountain and Pacific regions and Hawaii. Electricity uses much fewer Btus per acre than other sources of energy as conversion losses in electric motors are less than in internal combustion engines. However, as discussed earlier, the Btus required to generate the electricity at the power plant are not included herein.

Texas spent by far the most money for pumping irrigation water followed by California, Nebraska, Arizona, New Mexico, Idaho, and Kansas (table 18, 19, and 20). Per acre, natural gas is the cheapest source of energy, followed by electricity, diesel, LPG, and gasoline.

^{13/} As an example of this rapid increase, acreage irrigated with center pivot in Oregon increased from 15,000 acres in 1973 to 95,000 acres in 1975, according to correspondence with Marvin Shearer, extension irrigation specialist, Oregon State Univ., Oct. 27, 1975.

Table 11--Acres irrigated with pumped water by type of energy, 1974^{1/}

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>1,000 acres</u>					
Northeast:					
Maine	30.44	67.58	176.24	0.00	18.17
Massachusetts	0.69	2.08	4.16	0.00	0.00
New Hampshire	4.25	0.00	24.51	0.00	3.92
Vermont	0.59	1.78	3.56	0.00	0.00
Rhode Island	0.20	0.59	1.19	0.00	0.00
Connecticut	0.30	0.89	1.78	0.00	0.00
New York	0.92	2.38	5.50	0.00	0.12
New Jersey	5.87	23.48	29.35	0.00	0.00
Pennsylvania	10.57	15.85	73.98	0.00	5.28
Delaware	2.07	3.20	13.37	0.00	0.19
Maryland	2.59	7.78	11.67	0.00	3.89
Lake States:	295.76	81.34	23.17	0.00	10.52
Michigan	87.36	16.38	5.46	0.00	0.00
Wisconsin	136.08	25.51	8.50	0.00	0.00
Minnesota	72.32	39.45	9.20	0.00	10.52
Corn Belt:	71.43	74.55	122.88	1.81	99.31
Ohio	11.06	4.74	12.64	0.00	3.16
Indiana	3.32	4.65	13.30	0.38	11.59
Illinois	6.00	9.00	24.50	0.00	10.50
Iowa	11.50	20.13	23.00	0.00	2.88
Missouri	39.55	36.14	49.44	1.43	71.19
Northern Plains:	1,572.54	1,543.16	152.09	2,429.50	1,552.95
North Dakota	42.18	8.88	3.33	0.00	1.11
South Dakota	52.12	36.08	8.02	0.00	37.42
Nebraska	1,308.34	1,360.00	594.14	637.50	1,331.42
Kansas	169.90	138.20	22.40	1,792.00	183.00
Appalachian:	104.60	21.72	62.01	0.30	3.59
Virginia	2.93	6.60	24.94	0.00	2.20
West Virginia	0.24	0.59	2.14	0.00	0.00
North Carolina	98.05	5.45	5.45	0.00	0.00
Kentucky	0.00	4.01	22.73	0.00	0.00
Tennessee	3.38	5.07	6.76	0.30	1.39
Southeast:	584.83	1,044.72	188.86	0.16	222.01
South Carolina	32.52	7.88	0.00	0.00	0.00
Georgia	7.71	73.29	82.93	0.00	28.93
Florida	541.87	953.62	96.00	0.00	192.00
Alabama	3.72	9.93	9.93	0.16	1.08
Delta States:	504.02	645.22	590.49	204.53	744.00
Mississippi	63.92	191.76	31.96	0.00	31.96
Arkansas	339.20	184.40	424.00	70.00	678.40
Louisiana	100.90	269.06	134.53	134.53	33.63
Southern Plains:	2,006.68	151.25	108.38	6,742.20	508.88
Oklahoma	102.00	48.76	20.40	435.20	113.42
Texas	1,904.68	102.49	87.98	6,307.00	395.45
Mountain:	3,832.81	296.30	122.13	1,171.84	178.84
Montana	270.51	36.93	13.74	0.40	3.25
Idaho	1,083.07	11.52	29.09	17.00	11.52
Wyoming	191.41	18.02	2.75	7.00	6.01
Colorado	1,100.00	100.00	20.00	330.00	100.00
New Mexico	203.93	46.65	31.10	484.19	54.42
Arizona	612.95	0.00	0.00	330.05	0.00
Utah	211.50	42.30	23.40	3.20	1.60
Nevada	159.44	40.88	2.04	0.00	2.04
Pacific:	6,545.58	11.24	0.00	85.00	0.00
Washington	1,267.82	0.00	0.00	0.00	0.00
Oregon	755.65	7.63	0.00	0.00	0.00
California	4,522.11	3.61	0.00	85.00	0.00
Alaska	2.80	.20	1.00	0.00	0.00
Hawaii	71.63	0.00	.72	0.00	0.00
Total	15,621.14	3,934.69	1,547.97	10,635.33	3,338.27

^{1/} Includes only acres irrigated with pumped water.

Table 12--Quantity of energy used in units of fuel for onfarm pumping of irrigation water,
1974^{1/}

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
	1,000 kWh	1,000 gal.	1,000 MCF	1,000 gal.	
Groundwater:					
Northeast:	6,751	1,149	4,362	0	546
Maine	0	0	0	0	0
Massachusetts	30	0	18	0	4
New Hampshire	0	0	0	0	0
Vermont	0	0	0	0	0
Rhode Island	0	0	0	0	0
Connecticut	30	0	18	0	4
New York	778	256	401	0	0
New Jersey	4,740	585	3,417	0	305
Pennsylvania	72	9	48	0	1
Delaware	782	193	363	0	151
Maryland	320	105	99	0	82
Lake States:	90,975	2,131	750	0	462
Michigan	21,940	339	141	0	0
Wisconsin	44,378	685	286	0	0
Minnesota	24,657	1,107	323	0	462
Corn Belt:	12,446	1,185	2,792	6	2,391
Ohio	1,455	51	171	0	54
Indiana	1,158	133	477	3	507
Illinois	2,435	301	1,024	0	549
Iowa	2,156	312	446	0	70
Missouri	5,231	388	673	3	1,212
Northern Plains:	1,088,248	92,922	5,573	25,551	112,776
North Dakota	17,445	302	142	0	59
South Dakota	12,850	732	204	0	1,187
Nebraska	926,210	84,140	3,289	6,166	94,569
Kansas	131,744	7,747	1,938	19,383	16,961
Appalachian:	2,089	83	208	1	24
Virginia	106	20	92	0	10
West Virginia	0	0	0	0	0
North Carolina	1,542	7	9	0	0
Kentucky	0	2	16	0	0
Tennessee	440	54	91	1	14
Southeast:	143,931	12,666	6,029	1	10,723
South Carolina	7,988	164	0	0	0
Georgia	1,805	1,412	1,199	0	872
Florida	133,798	11,015	3,937	0	9,843
Alabama	339	74	93	1	9
Delta States:	123,858	14,066	14,482	680	22,289
Mississippi	21,752	5,372	1,120	0	1,400
Arkansas	76,932	3,167	9,905	248	19,808
Louisiana	25,174	5,527	3,457	432	1,080
Southern Plains:	1,376,236	8,783	8,759	66,344	43,792
Oklahoma	108,197	3,563	2,229	5,943	11,143
Texas	1,268,040	5,220	6,530	60,401	32,649
Mountain:	5,237,024	26,238	15,345	34,918	22,736
Montana	36,431	591	687	7	66
Idaho	1,482,899	1,299	3,250	406	2,031
Wyoming	201,484	1,561	244	122	610
Colorado	397,900	1,178	300	4,700	1,842
New Mexico	398,884	9,383	7,825	15,161	17,117
Arizona	2,081,935	0	0	14,432	0
Utah	255,079	4,365	2,548	91	455
Nevada	372,417	7,862	492	0	615
Pacific:	5,459,186	364	0	1,164	0
Washington	593,187	0	0	0	0
Oregon	437,614	364	0	0	0
California	4,428,386	0	0	1,164	0
Alaska	329	2	12	0	0
Hawaii	695,434	0	723	0	0
Total groundwater	14,236,501	159,589	59,036	128,665	215,739

^{1/}Totals may not add due to rounding.

Continued

Table 12--Quantity of energy used in units of fuel for onfarm pumping of irrigation water, 1974^{1/}--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
	1,000 kWh	--1,000 gal.--		1,000 MCF	1,000 gal.
<u>Surface water</u>					
Northeast:	3,904	718	2,259	0	333
Maine	116	29	72	0	0
Massachusetts	665	0	395	0	79
New Hampshire	103	26	64	0	0
Vermont	34	9	21	0	0
Rhode Island	52	13	32	0	0
Connecticut	138	34	85	0	0
New York	594	195	306	0	0
New Jersey	1,039	128	749	0	67
Pennsylvania	403	51	268	0	5
Delaware	209	52	97	0	40
Maryland	551	182	170	0	142
Lake States:	41,842	828	310	0	115
Michigan	15,767	243	101	0	0
Wisconsin	19,911	307	128	0	0
Minnesota	6,164	277	81	0	115
Corn Belt:	3,631	247	621	0	553
Ohio	1,800	63	212	0	66
Indiana	531	61	219	0	246
Illinois	0	0	0	0	0
Iowa	307	44	63	0	10
Missouri	994	78	128	0	230
Northern Plains:	45,788	2,092	1,637	0	9,898
North Dakota	1,857	32	15	0	6
South Dakota	31,336	1,786	497	0	2,896
Nebraska	10,931	0	1,126	0	6,567
Kansas	1,664	274	0	0	428
Appalachian:	21,013	336	1,173	0	98
Virginia	660	122	578	0	64
West Virginia	59	12	54	0	0
North Carolina	19,756	90	113	0	0
Kentucky	0	45	317	0	0
Tennessee	538	66	111	0	35
Southeast:	29,422	6,205	1,384	0	568
South Carolina	7,317	151	0	0	0
Georgia	1,135	888	1,257	0	548
Florida	20,506	5,064	0	0	0
Alabama	465	102	128	0	20
Delta States:	14,982	2,146	1,837	96	2,305
Mississippi	1,816	448	94	0	117
Arkansas	7,562	467	974	0	1,947
Louisiana	5,604	1,230	770	96	241
Southern Plains:	138,798	1,122	477	3,574	6,420
Oklahoma	0	360	0	0	2,251
Texas	138,798	762	477	3,574	4,169
Mountain:	331,335	2,968	1,907	4	419
Montana	141,992	1,513	516	0	215
Idaho	97,674	86	428	0	134
Wyoming	7,239	56	18	0	55
Colorado	2,100	0	1	0	0
New Mexico	5,159	0	0	4	0
Arizona	0	0	0	0	0
Utah	67,855	1,117	932	0	0
Nevada	9,317	197	12	0	15
Pacific:	4,403,185	1,028	0	0	0
Washington	3,167,082	0	0	0	0
Oregon	1,152,404	958	0	0	0
California	83,700	69	0	0	0
Alaska	72	0	3	0	0
Hawaii	220	0	0	0	0
Total surface water	5,034,191	17,688	11,609	3,673	20,708
Total groundwater and surface water	9,270,692	177,277	70,645	132,338	236,447

^{1/} Totals may not add due to rounding.

Table 13--Quantity of energy used per acre in units of fuel for onfarm pumping of irrigation water, 1974

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
Groundwater	kWh	----Gal.----	MCF	Gal.	
Northeast:					
Maine	489.93	35.05	53.32	0.00	63.45
Massachusetts	0.00	0.00	0.00	0.00	0.00
New Hampshire	227.44	0.00	23.42	0.00	29.28
Vermont	0.00	0.00	0.00	0.00	0.00
Rhode Island	0.00	0.00	0.00	0.00	0.00
Connecticut	228.86	0.00	23.57	0.00	29.46
New York	259.46	21.36	26.72	0.00	0.00
New Jersey	631.98	52.03	65.09	0.00	81.36
Pennsylvania	327.34	26.95	33.71	0.00	42.14
Delaware	391.10	32.20	40.28	0.00	50.35
Maryland	399.39	32.88	41.14	0.00	51.42
Lake States:					
Michigan	500.14	42.41	52.49	0.00	70.38
Wisconsin	489.73	40.32	50.44	0.00	0.00
Minnesota	482.37	39.71	49.68	0.00	0.00
	546.72	45.01	56.31	0.00	70.38
Corn Belt:					
Ohio	245.48	20.90	30.14	3.51	33.14
Indiana	346.47	28.52	35.68	0.00	44.60
Illinois	609.42	50.17	62.77	7.85	78.46
Iowa	405.89	33.42	41.80	0.00	52.25
Missouri	216.63	17.83	22.31	0.00	27.89
	182.90	15.06	18.84	2.35	23.55
Northern Plains:					
North Dakota	760.40	62.41	80.24	10.52	98.32
South Dakota	695.40	57.26	71.64	0.00	89.55
Nebraska	766.24	63.08	78.92	0.00	98.64
Kansas	751.49	61.87	77.40	9.67	96.75
	840.20	69.17	86.54	10.82	108.17
Appalachian:					
Virginia	342.27	26.83	30.07	4.72	40.61
West Virginia	264.03	21.74	27.19	0.00	33.99
North Carolina	0.00	0.00	0.00	0.00	0.00
Kentucky	342.66	28.21	35.29	0.00	0.00
Tennessee	0.00	14.61	18.28	0.00	0.00
	366.88	30.20	37.79	4.72	47.23
Southeast:					
South Carolina	410.29	34.03	45.13	3.63	52.50
Georgia	768.09	63.24	0.00	0.00	0.00
Florida	564.20	46.45	58.11	0.00	72.63
Alabama	398.21	32.78	41.01	0.00	51.26
	282.24	23.24	29.07	3.63	36.34
Delta States:					
Mississippi	329.23	34.17	32.87	4.93	37.17
Arkansas	481.23	39.62	49.56	0.00	61.95
Louisiana	274.76	22.62	28.30	3.54	35.37
	493.60	40.64	50.84	6.35	63.55
Southern Plains:					
Oklahoma	875.91	76.87	93.32	11.30	116.64
Texas	1,060.75	87.33	109.25	13.66	136.56
	863.08	71.06	88.89	11.11	111.11
Mountain:					
Montana	1,647.34	159.26	165.28	29.27	253.30
Idaho	1,282.79	105.61	132.12	16.51	165.14
Wyoming	1,855.94	152.79	191.15	23.89	238.93
Colorado	1,354.51	111.51	139.51	17.44	174.38
New Mexico	447.14	36.81	46.05	5.76	57.56
Arizona	2,443.03	201.13	251.62	31.45	314.51
Utah	3,396.58	0.00	0.00	43.73	0.00
Nevada	2,208.57	181.86	227.51	28.44	284.38
	2,808.57	231.22	289.27	0.00	361.57
Pacific:					
Washington	1,241.82	193.57	0.00	1,369.00	0.00
Oregon	2,965.93	0.00	0.00	0.00	0.00
California	2,351.24	193.57	0.00	0.00	0.00
	1,063.23	0.00	0.00	42.35	0.00
Alaska	156.47	12.88	16.12	0	0
Hawaii	10,035.16		1,033.60	0	0

Table 13--Quantity of energy used per acre in units of fuel for onfarm pumping of irrigation water, 1974--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
Surface water	kWh	-----Gal.-----	MCF	Gal.	
Northeast:					
Maine	234.30	20.63	23.92	0.00	34.81
Massachusetts	167.34	13.78	17.24	0.00	0.00
New Hampshire	161.53	0.00	16.64	0.00	20.80
Vermont	173.92	14.32	17.91	0.00	0.00
Rhode Island	173.92	14.32	17.91	0.00	0.00
Connecticut	173.92	14.32	17.91	0.00	0.00
New York	206.82	17.03	21.30	0.00	0.00
New Jersey	338.44	27.86	34.86	0.00	43.57
Pennsylvania	217.68	17.92	22.42	0.00	28.02
Delaware	351.24	28.92	36.18	0.00	45.22
Maryland	348.11	28.66	35.85	0.00	44.82
Lake States:	367.47	26.61	34.96	0.00	29.15
Michigan	370.45	30.50	38.15	0.00	0.00
Wisconsin	451.70	37.19	46.52	0.00	0.00
Minnesota	226.42	18.64	23.32	0.00	29.15
Corn Belt:	175.10	13.73	20.57	0.00	20.33
Ohio	262.32	21.60	27.02	0.00	33.77
Indiana	372.84	30.69	38.40	0.00	48.00
Illinois	0.00	0.00	0.00	0.00	0.00
Iowa	204.37	16.83	21.05	0.00	26.31
Missouri	90.73	7.47	9.34	0.00	11.68
Northern Plains:	323.85	38.55	19.82	0.00	24.38
North Dakota	108.61	8.94	11.19	0.00	13.98
South Dakota	886.55	72.99	91.31	0.00	114.13
Nebraska	144.13	0.00	14.84	0.00	18.55
Kansas	127.02	10.46	0.00	0.00	16.35
Appalachian:	213.31	18.04	21.29	0.00	32.90
Virginia	260.48	21.44	26.83	0.00	33.53
West Virginia	246.38	20.28	25.38	0.00	0.00
North Carolina	211.17	17.38	21.75	0.00	0.00
Kentucky	0.00	11.59	14.49	0.00	0.00
Tennessee	246.99	20.33	25.44	0.00	31.80
Southeast:	125.72	9.23	25.05	0.00	31.96
South Carolina	346.45	28.52	0.00	0.00	0.00
Georgia	251.44	20.70	25.90	0.00	32.37
Florida	99.60	8.20	0.00	0.00	0.00
Alabama	183.99	15.15	18.95	0.00	23.69
Delta States:	117.21	9.18	12.25	1.45	15.96
Mississippi	97.00	7.99	9.99	0.00	12.49
Arkansas	127.74	10.52	13.16	0.00	16.44
Louisiana	112.31	9.25	11.57	1.45	14.46
Southern Plains:	318.72	30.32	32.83	4.10	48.11
Oklahoma	0.00	45.22	0.00	0.00	70.72
Texas	318.72	26.24	32.83	4.10	41.03
Mountain:	430.46	46.71	55.13	1.63	48.03
Montana	586.49	48.28	60.40	0.00	75.50
Idaho	343.84	28.31	35.41	0.00	44.27
Wyoming	169.68	13.97	17.48	0.00	21.84
Colorado	71.20	0.00	7.33	0.00	0.00
New Mexico	126.89	0.00	0.00	1.63	0.00
Arizona	0.00	0.00	0.00	0.00	0.00
Utah	741.59	61.05	76.38	0.00	0.00
Nevada	347.13	28.58	35.75	0.00	44.69
Pacific:	2,214.09	110.47	0.00	0.00	0.00
Washington	2,965.93	0.00	0.00	0.00	0.00
Oregon	2,023.44	166.58	0.00	0.00	0.00
California	233.78	19.24	0.00	0.00	0.00
Alaska	103.87	0.00	10.70	0.00	0.00
Hawaii	801.42	0.00	0.00	0.00	0.00

Table 14--Quantity of energy used per acre-foot for onfarm pumping of irrigation water, 1974

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
	kWh	----Gal----		MCF	Gal.
Groundwater					
Northeast:	711.68	50.91	77.45	0.00	92.17
Maine	0.00	0.00	0.00	0.00	0.00
Massachusetts	545.41	0.00	56.17	0.00	70.22
New Hampshire	0.00	0.00	0.00	0.00	0.00
Vermont	0.00	0.00	0.00	0.00	0.00
Rhode Island	0.00	0.00	0.00	0.00	0.00
Connecticut	548.83	0.00	56.53	0.00	70.66
New York	622.20	51.22	64.08	0.00	0.00
New Jersey	758.68	62.46	78.14	0.00	97.67
Pennsylvania	784.98	64.63	80.85	0.00	101.06
Delaware	670.85	55.23	69.09	0.00	87.36
Maryland	532.52	43.84	54.85	0.00	68.56
Lake States:	650.07	55.12	68.23	0.00	93.85
Michigan	734.23	60.45	75.62	0.00	0.00
Wisconsin	579.07	47.67	59.64	0.00	0.00
Minnesota	728.97	60.01	75.08	0.00	93.85
Corn Belt:	431.63	36.76	52.99	6.17	58.28
Ohio	692.94	57.05	71.37	0.00	89.21
Indiana	731.59	60.23	75.35	9.42	94.18
Illinois	608.52	50.10	62.67	0.00	78.34
Iowa	371.58	30.59	38.27	0.00	47.84
Missouri	365.80	30.12	37.68	4.71	47.09
Northern Plains:	444.32	36.47	46.88	6.15	57.45
North Dakota	695.57	57.26	71.64	0.00	89.55
South Dakota	612.99	50.47	63.14	0.00	78.92
Nebraska	409.98	33.75	42.23	5.28	52.78
Kansas	560.14	46.11	57.69	7.21	72.11
Appalachian:	658.87	51.65	57.89	9.09	78.18
Virginia	528.05	43.47	54.39	0.00	67.98
West Virginia	0.00	0.00	0.00	0.00	0.00
North Carolina	685.31	56.42	70.58	0.00	0.00
Kentucky	0.00	43.88	54.90	0.00	0.00
Tennessee	629.30	51.81	64.81	8.10	81.01
Southeast:	559.56	46.41	61.65	10.91	71.60
South Carolina	1,151.57	94.81	0.00	0.00	0.00
Georgia	967.75	79.67	99.67	0.00	124.59
Florida	530.95	43.71	54.68	0.00	68.35
Alabama	847.57	69.78	87.29	10.91	109.11
Delta States:	182.48	18.94	18.22	2.73	20.60
Mississippi	304.00	25.03	31.31	0.00	39.14
Arkansas	149.90	12.34	15.44	1.93	19.30
Louisiana	269.29	22.17	27.74	3.47	24.67
Southern Plains:	589.50	51.73	62.80	7.60	78.50
Oklahoma	795.76	65.51	81.96	10.24	102.45
Texas	575.39	47.37	59.26	7.41	74.07
Mountain:	708.48	68.49	71.08	12.59	108.94
Montana	641.40	52.80	66.06	8.26	82.57
Idaho	742.38	61.12	76.46	9.56	95.57
Wyoming	738.96	60.84	76.11	9.51	95.13
Colorado	412.87	33.99	42.52	5.32	53.15
New Mexico	977.21	80.45	100.65	12.58	125.81
Arizona	849.15	0.00	0.00	10.93	0.00
Utah	736.33	60.62	75.84	9.48	94.79
Nevada	936.19	77.07	96.42	0.00	120.52
Pacific:	391.25	60.86	0.00	4.32	0.00
Washington	780.51	0.00	0.00	0.00	0.00
Oregon	829.95	60.33	0.00	0.00	0.00
California	335.72	0.00	0.00	4.32	0.00
Alaska	625.80	51.52	64.48	0.00	0.00
Hawaii	167.25	0.00	17.22	0.00	0.00

Continued

Table 14--Quantity of energy used per acre-foot for onfarm pumping of irrigation water, 1974
--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
	kWh	-----Gal.-----		MCF	Gal.
Surface water					
	:				
Northeast:	434.36	38.24	44.35	0.00	64.53
Maine	401.30	33.04	41.33	0.00	0.00
Massachusetts	387.36	0.00	39.90	0.00	49.87
New Hampshire	417.08	34.34	42.96	0.00	0.00
Vermont	417.08	34.34	42.96	0.00	0.00
Rhode Island	417.08	34.34	42.96	0.00	0.00
Connecticut	417.08	34.34	42.96	0.00	0.00
New York	495.97	40.83	51.08	0.00	0.00
New Jersey	406.30	33.45	41.85	0.00	0.00
Pennsylvania	522.01	42.98	53.76	0.00	67.20
Delaware	602.47	49.60	62.05	0.00	77.66
Maryland	464.15	38.21	47.80	0.00	59.75
Lake States:	489.30	35.44	46.55	0.00	38.87
Michigan	555.40	45.72	57.20	0.00	0.00
Wisconsin	542.25	44.64	55.85	0.00	0.00
Minnesota	301.89	24.85	31.09	0.00	38.87
Corn Belt:	315.02	24.70	37.00	0.00	36.58
Ohio	525.63	43.19	54.03	0.00	67.54
Indiana	447.58	36.85	46.10	0.00	57.62
Illinois	0.00	0.00	0.00	0.00	0.00
Iowa	350.54	28.86	36.10	0.00	45.13
Missouri	181.45	14.94	18.69	0.00	23.36
Northern Plains:	190.89	22.72	11.68	0.00	14.37
North Dakota	108.61	8.94	11.19	0.00	13.98
South Dakota	709.24	58.39	73.05	0.00	91.31
Nebraska	78.63	0.00	8.10	0.00	10.12
Kansas	84.68	6.97	0.00	0.00	10.90
Appalachian:	442.53	37.42	44.16	0.00	68.25
Virginia	520.95	42.89	53.66	0.00	67.07
West Virginia	422.60	34.79	43.53	0.00	0.00
North Carolina	422.34	34.77	43.50	0.00	0.00
Kentucky	0.00	34.79	43.53	0.00	0.00
Tennessee	423.65	34.88	43.63	0.00	54.54
Southeast:	174.21	12.79	34.71	0.00	8.86
South Carolina	511.75	42.13	0.00	0.00	7.89
Georgia	431.28	35.51	44.42	0.00	8.97
Florida	132.80	10.93	0.00	0.00	7.89
Alabama	552.51	45.49	56.91		
Delta States:	65.10	5.10	6.81	0.79	8.86
Mississippi	61.27	5.04	6.31	0.00	7.89
Arkansas	69.69	5.74	7.18	0.00	8.97
Louisiana	61.27	5.04	6.31	0.79	7.89
Southern Plains:	212.48	20.28	21.88	2.74	32.17
Oklahoma	0.00	33.93	0.00	0.00	53.05
Texas	212.48	17.49	21.88	2.74	27.35
Mountain:	169.25	18.36	21.68	0.65	18.88
Montana	217.22	17.88	22.37	0.00	27.96
Idaho	137.54	11.32	14.17	0.00	17.71
Wyoming	92.57	7.62	9.53	0.00	11.92
Colorado	65.74	0.00	6.77	0.00	0.00
New Mexico	50.75	0.00	0.00	0.65	0.00
Arizona	0.00	0.00	0.00	0.00	0.00
Utah	247.20	20.35	25.46	0.00	0.00
Nevada	115.71	9.53	11.92	0.00	14.90
Pacific:	637.24	31.14	0.00	0.00	0.00
Washington	780.51	0.00	0.00	0.00	0.00
Oregon	714.24	58.80	0.00	0.00	0.00
California	73.81	6.08	0.00	0.00	0.00
Alaska	414.28	0.00	42.80	0.00	0.00
Hawaii	133.57	0.00	0.00	0.00	0.00
	:				

Table 15--Quantity of energy used in Btus for onfarm pumping of irrigation water,
1974^{1/}

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG	Total
<u>Groundwater</u>				<u>Billion Btu</u>		
Northeast:	23.0	160.9	545.3	0.0	51.9	781.1
Maine	0.0	0.0	0.0	0.0	0.0	0.0
Massachusetts	0.1	0.0	2.2	0.0	0.3	2.6
New Hampshire	0.0	0.0	0.0	0.0	0.0	0.0
Vermont	0.0	0.0	0.0	0.0	0.0	0.0
Rhode Island	0.0	0.0	0.0	0.0	0.0	0.0
Connecticut	0.1	0.0	2.2	0.0	0.3	2.6
New York	2.7	35.9	50.1	0.0	0.0	88.7
New Jersey	16.2	81.9	427.2	0.0	29.0	554.3
Pennsylvania	0.2	1.3	6.0	0.0	1.0	8.5
Delaware	2.7	27.0	45.3	0.0	14.3	89.3
Maryland	1.1	14.7	12.3	0.0	7.8	35.9
Lake States:	310.5	298.3	93.8	0.0	43.9	746.5
Michigan	74.9	47.4	17.7	0.0	0.0	140.0
Wisconsin	151.5	95.9	35.7	0.0	0.0	283.1
Minnesota	84.2	155.0	40.4	0.0	43.9	323.5
Corn Belt:	42.5	165.9	349.0	6.7	277.1	791.2
Ohio	5.0	7.2	21.4	0.0	5.1	38.7
Indiana	4.0	18.7	59.6	3.1	48.1	133.5
Illinois	8.3	42.1	128.0	0.0	52.1	230.5
Iowa	7.4	43.7	55.8	0.0	6.6	113.5
Missouri	17.9	54.3	84.2	3.5	115.1	275.1
Northern Plains:	3,714.2	13,009.1	696.7	26,828.5	10,713.7	54,962.2
North Dakota	59.5	42.3	17.7	0.0	5.6	125.1
South Dakota	43.9	102.5	25.5	0.0	112.8	284.7
Nebraska	3,161.2	11,779.7	411.2	6,475.9	8,984.0	30,812.0
Kansas	449.6	1,084.6	242.3	20,352.6	1,611.2	23,740.3
Appalachian:	7.1	11.6	25.9	1.5	2.3	48.4
Virginia	0.4	2.7	11.6	0.0	1.0	15.7
West Virginia	0.0	0.0	0.0	0.0	0.0	0.0
North Carolina	5.3	1.0	1.1	0.0	0.0	7.4
Kentucky	0.0	0.3	1.9	0.0	0.0	2.2
Tennessee	1.5	7.6	11.6	1.5	1.3	23.2
Southeast:	491.2	1,773.2	753.7	0.6	1,018.7	4,037.4
South Carolina	27.3	23.0	0.0	0.0	0.0	50.3
Georgia	6.2	197.7	249.9	0.0	82.8	536.6
Florida	456.7	1,542.1	492.1	0.0	935.1	3,425.4
Alabama	1.2	10.4	11.6	0.6	0.8	24.6
Delta States:	422.7	1,969.2	1,810.2	713.7	2,177.4	7,023.2
Mississippi	74.2	752.1	140.0	0.0	133.0	1,099.3
Arkansas	262.6	443.4	1,238.1	260.0	1,881.8	4,085.9
Louisiana	85.9	773.7	432.1	453.7	102.6	1,848.0
Southern Plains:	4,697.1	1,229.6	1,094.9	69,661.2	4,160.3	80,843.1
Oklahoma	369.3	498.8	278.6	6,240.2	1,058.6	8,445.5
Texas	4,327.8	730.8	816.3	63,421.0	3,101.7	72,397.6
Mountain:	17,874.0	3,673.3	1,919.0	36,665.0	2,160.0	62,291.3
Montana	124.3	82.8	85.9	6.9	6.3	306.2
Idaho	5,061.1	181.8	406.2	426.5	192.9	6,268.5
Wyoming	687.7	218.6	30.5	128.2	58.0	1,123.0
Colorado	1,358.0	164.9	38.0	4,935.0	175.0	6,670.9
New Mexico	1,361.4	1,313.6	978.2	15,919.0	1,626.1	21,198.3
Arizona	7,105.6	0.0	0.0	15,153.7	0.0	22,259.3
Utah	904.7	611.0	318.5	95.6	43.2	1,973.0
Nevada	1,271.1	1,100.6	61.5	0.0	58.4	2,491.6
Pacific:	18,632.2	50.9	0.0	1,221.7	0.0	19,904.8
Washington	2,024.5	0.0	0.0	0.0	0.0	2,024.5
Oregon	1,493.6	50.9	0.0	0.0	0.0	1,544.5
California	15,114.1	0.0	0.0	1,221.7	0.0	16,335.8
Alaska	1.1	0.2	1.5	0.0	0.0	2.8
Hawaii	2,373.5	0.0	90.4	0.0	0.0	2,463.9
Total	48,579.8	22,342.4	7,379.9	135,097.8	20,555.0	233,957.0

^{1/}Totals may not add due to rounding.

Continued

Table 15--Quantity of energy used in Btus for onfarm pumping or irrigation water, 1974^{1/}--
Continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG	Total
<u>Surface water</u>				<u>Billion Btu</u>		
Northeast:	13.3	100.5	282.3	0.0	31.6	427.7
Maine	.4	4.0	8.9	0.0	0.0	13.3
Massachusetts	.4	3.6	7.9	0.0	0.0	11.9
New Hampshire	.1	1.2	2.7	0.0	0.0	4.0
Vermont	2.3	0.0	49.4	0.0	7.5	59.2
Rhode Island	.2	1.8	3.9	0.0	0.0	5.9
Connecticut	.5	4.9	10.6	0.0	0.0	16.0
New York	2.0	27.4	38.2	0.0	0.0	67.6
New Jersey	3.5	17.9	93.6	0.0	6.3	121.3
Pennsylvania	1.4	7.2	33.5	0.0	.4	42.5
Delaware	.7	7.2	12.1	0.0	3.8	23.8
Maryland	1.9	25.4	21.3	0.0	13.5	62.1
Lake States:	142.8	115.9	38.8	0.0	10.9	308.4
Michigan	53.8	34.1	12.7	0.0	0.0	100.6
Wisconsin	67.9	43.0	16.0	0.0	0.0	126.9
Minnesota	21.0	38.8	10.1	0.0	10.9	80.8
Corn Belt:	12.4	34.5	77.7	0.0	52.5	177.1
Ohio	6.1	8.9	26.5	0.0	6.3	47.8
Indiana	1.8	8.6	27.4	0.0	23.4	61.2
Illinois	0.0	0.0	0.0	0.0	0.0	0.0
Iowa	1.0	6.1	7.9	0.0	.9	15.9
Missouri	3.4	10.9	15.9	0.0	21.9	52.1
Northern Plains:	156.3	292.9	204.7	0.0	940.3	1,594.2
North Dakota	6.4	4.5	1.9	0.0	6.6	13.4
South Dakota	106.9	250.0	62.1	0.0	275.1	694.1
Nebraska	37.3	0.0	140.7	0.0	623.9	801.9
Kansas	5.7	38.3	0.0	0.0	40.7	84.7
Appalachian:	71.7	47.0	146.6	0.0	9.3	274.6
Virginia	2.3	17.1	72.2	0.0	6.1	97.7
West Virginia	.2	1.7	6.8	0.0	0.0	8.7
North Carolina	67.4	12.7	14.1	0.0	0.0	94.2
Kentucky	0.0	6.3	39.6	0.0	0.0	45.9
Tennessee	1.8	9.3	13.9	0.0	3.3	28.8
Southeast:	100.4	868.7	173.0	0.0	53.9	1,196.0
South Carolina	24.9	21.1	0.0	0.0	0.0	46.0
Georgia	3.9	124.3	157.1	0.0	52.0	337.3
Florida	69.9	709.0	0.0	0.0	0.0	778.9
Alabama	1.6	14.3	15.9	0.0	1.9	33.6
Delta States:	51.1	300.4	229.6	101.0	218.9	901.0
Mississippi	6.2	62.8	11.7	0.0	11.1	91.8
Arkansas	25.8	65.4	121.7	0.0	184.9	397.8
Louisiana	19.1	172.2	96.2	101.0	22.8	411.3
Southern Plains:	473.7	157.0	59.6	3,752.4	609.9	5,052.6
Oklahoma	0.0	50.4	0.0	0.0	213.8	264.2
Texas	473.7	106.7	59.6	3,752.4	396.1	4,787.5
Mountain:	1,134.5	415.6	238.3	3.7	39.8	1,832.2
Montana	484.6	211.8	64.5	0.0	20.4	781.3
Idaho	333.4	11.9	53.5	0.0	12.7	411.5
Wyoming	24.7	7.9	2.2	0.0	5.2	40.0
Colorado	7.1	0.0	0.1	0.0	0.0	7.2
New Mexico	17.6	0.0	0.0	3.7	0.0	21.3
Arizona	0.0	0.0	0.0	0.0	0.0	0.0
Utah	231.6	156.4	6.5	0.0	0.0	504.5
Nevada	31.8	27.5	1.5	0.0	1.5	62.3
Pacific:	15,027.3	143.9	0.0	0.0	0.0	15,171.2
Washington	10,809.3	0.0	0.0	0.0	0.0	10,809.3
Oregon	3,933.5	134.2	0.0	0.0	0.0	4,067.7
California	284.9	9.7	0.0	0.0	0.0	294.6
Alaska	0.2	0.0	0.3	0.0	0.0	0.5
Hawaii	0.7	0.0	0.0	0.0	0.0	0.7
Total surface water	17,180.7	2,476.3	1,451.0	3,857.1	1,967.3	26,932.4
Total groundwater and surface water	65,760.5	24,818.7	8,830.9	138,954.9	22,523.0	260,888.3

^{1/}Totals may not add due to rounding.

Table 16--Quantity of energy used per acre in Btus for onfarm pumping of irrigation water, 1974^{1/}

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>Groundwater</u>			<u>Million Btu</u>		
Northeast:					
Maine	1.57	1.71	6.66	0.00	6.03
Massachusetts	0.00	0.00	0.00	0.00	0.00
New Hampshire	0.78	0.00	2.93	0.00	2.78
Vermont	0.00	0.00	0.00	0.00	0.00
Rhode Island	0.00	0.00	0.00	0.00	0.00
Connecticut	0.78	0.00	2.95	0.00	2.80
New York	0.89	2.99	3.34	0.00	0.00
New Jersey	2.16	7.28	8.14	0.00	7.73
Pennsylvania	1.12	3.77	4.21	0.00	4.00
Delaware	1.33	4.51	5.04	0.00	4.78
Maryland	1.36	4.60	5.14	0.00	4.88
Lake States:	1.71	1.53	6.56	0.00	6.69
Michigan	1.67	5.64	6.30	0.00	0.00
Wisconsin	1.65	5.56	6.21	0.00	0.00
Minnesota	1.87	6.30	7.04	0.00	6.69
Corn Belt:	0.84	1.06	3.77	3.68	3.15
Ohio	1.18	3.99	4.46	0.00	4.24
Indiana	2.08	7.02	7.85	8.24	7.45
Illinois	1.39	4.68	5.23	0.00	4.96
Iowa	0.74	2.50	2.79	0.00	2.65
Missouri	0.62	2.11	2.35	2.47	2.24
Northern Plains:	2.60	1.16	10.03	11.04	9.34
North Dakota	2.37	8.02	8.95	0.00	8.51
South Dakota	2.62	8.83	9.86	0.00	9.37
Nebraska	2.56	8.66	9.67	10.16	9.19
Kansas	2.87	9.68	10.82	11.36	10.28
Appalachian:	1.17	1.32	3.76	4.96	3.86
Virginia	0.90	3.04	3.40	0.00	3.23
West Virginia	0.00	0.00	0.00	0.00	0.00
North Carolina	1.17	3.95	4.41	0.00	0.00
Kentucky	0.00	2.05	2.29	0.00	0.00
Tennessee	1.25	4.23	4.72	4.96	4.49
Southeast:	1.40	2.28	5.64	3.82	4.99
South Carolina	2.62	8.85	0.00	0.00	0.00
Georgia	1.93	6.50	7.26	0.00	6.90
Florida	1.36	4.59	5.13	0.00	4.87
Alabama	0.96	3.25	3.63	3.82	3.45
Delta States:	1.12	0.56	4.11	5.17	3.53
Mississippi	1.64	5.55	6.20	0.00	5.89
Arkansas	0.94	3.17	3.54	3.71	3.36
Louisiana	1.68	5.69	6.35	6.67	6.04
Southern Plains:	2.99	0.10	11.66	11.86	11.08
Oklahoma	3.62	12.23	13.66	14.34	12.97
Texas	2.95	9.95	11.11	11.67	10.56
Mountain:	5.62	0.34	20.66	30.73	24.06
Montana	4.38	14.79	16.52	17.34	15.69
Idaho	6.33	21.39	23.89	25.09	22.70
Wyoming	4.62	15.61	17.44	18.31	16.57
Colorado	1.53	5.15	5.76	6.04	5.47
New Mexico	8.34	28.16	31.45	33.02	29.88
Arizona	11.59	0.00	0.00	45.91	0.00
Utah	7.54	25.46	28.44	29.86	27.02
Nevada	9.59	32.37	36.16	0.00	34.35
Pacific:	5.39	27.10	0.00	14.37	0.00
Washington	10.12	0.00	0.00	0.00	0.00
Oregon	8.02	27.10	0.00	0.00	0.00
California	11.23	0.00	0.00	14.37	0.00
Alaska	.53	1.80	2.01	0.00	0.00
Hawaii	34.25	0.00	129.20	0.00	0.00

^{1/} Totals may not add due to rounding.

Continued

Table 16--Quantity of energy used per acre in Btus for onfarm pumping of irrigation water,
1974^{1/}--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
Surface water			Million Btu		
Northeast:					
Maine	0.57	1.93	2.15	0.00	0.00
Massachusetts	0.55	0.00	2.08	0.00	1.98
New Hampshire	0.59	2.00	2.24	0.00	0.00
Vermont	0.59	2.00	2.24	0.00	0.00
Rhode Island	0.59	2.00	2.24	0.00	0.00
Connecticut	0.59	2.00	2.24	0.00	0.00
New York	0.71	2.38	2.66	0.00	0.00
New Jersey	1.16	3.90	4.36	0.00	4.14
Pennsylvania	0.74	2.51	2.80	0.00	2.66
Delaware	1.20	4.05	4.52	0.00	4.30
Maryland	1.19	4.01	4.48	0.00	4.26
Lake States:	1.25	0.98	4.37	0.00	2.77
Michigan	1.26	4.27	4.77	0.00	0.00
Wisconsin	1.54	5.21	5.82	0.00	0.00
Minnesota	0.77	2.61	2.92	0.00	2.77
Corn Belt:	0.60	0.65	2.57	0.00	1.93
Ohio	0.90	3.02	3.38	0.00	3.21
Indiana	1.27	4.30	4.80	0.00	4.56
Illinois	0.00	0.00	0.00	0.00	0.00
Iowa	0.70	2.36	2.63	0.00	2.50
Missouri	0.31	1.05	1.17	0.00	1.11
Northern Plains:	1.111	0.25	2.48	0.00	2.32
North Dakota	0.37	1.25	1.40	0.00	1.33
South Dakota	3.03	10.22	11.41	0.00	10.84
Nebraska	0.49	0.00	1.86	0.00	1.76
Kansas	0.43	1.46	0.00	0.00	1.55
Appalachian:	0.73	0.56	2.66	0.00	3.13
Virginia	0.89	3.00	3.35	0.00	3.19
West Virginia	0.84	2.84	3.17	0.00	0.00
North Carolina	0.72	2.43	2.72	0.00	0.00
Kentucky	0.00	1.62	1.81	0.00	0.00
Tennessee	0.84	2.85	3.18	0.00	3.02
Southeast:	0.43	1.23	3.13	0.00	3.04
South Carolina	1.18	3.99	0.00	0.00	0.00
Georgia	0.86	2.90	3.24	0.00	3.08
Florida	0.34	1.15	0.00	0.00	0.00
Alabama	0.63	2.12	2.37	0.00	2.25
Delta States:	0.40	0.23	1.53	1.52	1.52
Mississippi	0.33	1.12	1.25	0.00	1.19
Arkansas	0.44	1.47	1.64	0.00	1.56
Louisiana	0.38	1.29	1.45	1.52	1.37
Southern Plains:	1.09	0.07	4.10	4.31	4.57
Oklahoma	0.00	6.33	0.00	0.00	6.72
Texas	1.09	3.67	4.10	4.31	3.90
Mountain:	1.47	0.19	6.89	1.72	4.56
Montana	2.00	6.76	7.55	0.00	7.17
Idaho	1.17	3.96	4.43	0.00	4.21
Wyoming	0.58	1.96	2.18	0.00	2.08
Colorado	0.24	0.00	0.92	0.00	0.00
New Mexico	0.43	0.00	0.00	1.72	0.00
Arizona	0.00	0.00	0.00	0.00	0.00
Utah	2.53	8.55	9.55	0.00	0.00
Nevada	1.18	4.00	4.47	0.00	4.25
Pacific:	7.39	18.41	0.00	0.00	0.00
Washington	10.12	0.00	0.00	0.00	0.00
Oregon	6.91	23.32	0.00	0.00	0.00
California	7.80	2.70	0.00	0.00	0.00
Alaska	0.35	1.20	1.34	0.00	0.00
Hawaii	0.32	0.00	1.22	0.00	0.00

1/ Totals may not add due to rounding.

Table 17--Quantity of energy used per acre-foot in Btus for onfarm pumping of irrigation water, 1974

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>Groundwater</u>			<u>Million Btu</u>		
Northeast:					
Maine	2.43	7.13	9.68	0.00	8.76
Massachusetts	0.00	0.00	0.00	0.00	0.00
New Hampshire	1.86	0.00	7.02	0.00	6.67
Vermont	0.00	0.00	0.00	0.00	0.00
Rhode Island	0.00	0.00	0.00	0.00	0.00
Connecticut	1.87	0.00	7.07	0.00	6.71
New York	2.12	7.17	8.01	0.00	0.00
New Jersey	2.59	8.74	9.77	0.00	9.28
Pennsylvania	2.68	9.05	10.11	0.00	9.60
Delaware	2.29	7.73	8.64	0.00	8.20
Maryland	1.82	6.14	6.86	0.00	6.51
Lake States:					
Michigan	2.22	7.72	8.53	0.00	8.92
Wisconsin	2.51	8.46	9.45	0.00	0.00
Minnesota	1.98	6.67	7.46	0.00	0.00
	2.49	8.40	9.38	0.00	8.92
Corn Belt:					
Ohio	1.47	5.15	6.62	6.48	5.54
Indiana	2.36	7.99	8.92	0.00	8.47
Illinois	2.50	8.43	9.42	9.89	8.95
Iowa	2.08	7.01	7.83	0.00	7.44
Missouri	1.27	4.28	4.78	0.00	4.54
	1.25	4.22	4.71	4.94	4.47
Northern Plains:					
North Dakota	1.52	5.11	5.86	6.45	5.46
South Dakota	2.37	8.02	8.95	0.00	8.51
Nebraska	2.09	7.07	7.89	0.00	7.50
Kansas	1.40	4.73	5.28	5.54	5.01
	1.91	6.46	7.21	7.57	6.85
Appalachian:					
Virginia	2.25	7.23	7.24	8.51	7.43
West Virginia	1.80	6.09	6.80	0.00	6.46
North Carolina	0.00	0.00	0.00	0.00	0.00
Kentucky	2.34	7.90	8.82	0.00	0.00
Tennessee	0.00	6.14	6.86	0.00	0.00
	2.15	7.25	8.10	8.51	7.70
Southeast:					
South Carolina	1.91	6.50	7.69	11.46	6.80
Georgia	3.93	13.27	0.00	0.00	0.00
Florida	3.30	11.15	12.46	0.00	11.84
Alabama	1.81	6.12	6.84	0.00	6.49
	2.89	9.77	10.91	11.46	10.37
Delta States:					
Mississippi	0.62	2.65	2.28	2.87	1.96
Arkansas	1.04	3.50	3.91	0.00	3.72
Louisiana	0.51	1.73	1.93	2.03	1.83
	0.92	3.10	3.47	3.64	3.29
Southern Plains:					
Oklahoma	2.01	7.24	7.85	7.99	7.46
Texas	2.72	9.17	10.24	10.76	9.73
	1.96	6.63	7.41	7.78	7.04
Mountain:					
Montana	2.42	9.59	8.89	13.22	10.35
Idaho	2.19	7.39	8.26	8.67	7.84
Wyoming	2.53	8.56	9.56	10.04	9.08
Colorado	2.52	8.52	9.51	9.99	9.04
New Mexico	1.41	4.76	5.32	5.58	5.05
Arizona	3.34	11.26	12.58	13.21	11.95
Utah	2.90	0.00	0.00	11.48	0.00
Nevada	2.51	8.49	9.48	9.95	9.01
	3.20	10.79	12.05	0.00	11.45
Pacific:					
Washington	1.29	9.57	0.00	4.54	0.00
Oregon	2.66	0.00	0.00	0.00	0.00
California	2.83	9.57	0.00	0.00	0.00
Alaska	1.15	0.00	0.00	4.54	0.00
Hawaii	2.14	7.21	8.06	0.00	0.00
	5.71	0.00	21.53	0.00	0.00

Continued

Table 17--Quantity of energy used per acre-foot in Btus for onfarm pumping of irrigation water, 1974--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>Surface water</u>			<u>Million Btu</u>		
Northeast:					
Maine	1.37	4.63	5.17	0.00	0.00
Massachusetts	1.32	0.00	4.99	0.00	4.74
New Hampshire	1.42	4.81	5.37	0.00	0.00
Vermont	1.42	4.81	5.37	0.00	0.00
Rhode Island	1.42	4.81	5.37	0.00	0.00
Connecticut	1.42	4.81	5.37	0.00	0.00
New York	1.69	5.72	6.39	0.00	0.00
New Jersey	1.39	4.68	5.23	0.00	4.97
Pennsylvania	1.78	6.02	6.72	0.00	6.38
Delaware	2.06	6.94	7.76	0.00	7.37
Maryland	1.58	5.35	5.98	0.00	5.68
Lake States:					
Michigan	1.90	6.40	7.15	0.00	0.00
Wisconsin	1.85	6.25	6.98	0.00	0.00
Minnesota	1.03	3.48	3.89	0.00	3.69
Corn Belt:					
Ohio	1.79	6.05	6.75	0.00	6.42
Indiana	1.53	5.16	5.76	0.00	5.47
Illinois	0.00	0.00	0.00	0.00	0.00
Iowa	1.20	4.04	4.51	0.00	4.29
Missouri	0.62	2.09	2.34	0.00	2.22
Northern Plains:					
North Dakota	0.37	1.25	1.40	0.00	1.33
South Dakota	2.42	8.17	9.13	0.00	8.67
Nebraska	0.27	0.00	1.01	0.00	0.96
Kansas	0.29	0.98	0.00	0.00	1.04
Appalachian:					
Virginia	1.78	6.00	6.71	0.00	6.37
West Virginia	1.44	4.87	5.44	0.00	0.00
North Carolina	1.44	4.87	5.44	0.00	0.00
Kentucky	0.00	4.87	5.44	0.00	0.00
Tennessee	1.45	4.88	5.45	0.00	5.18
Southeast:					
South Carolina	1.75	5.90	0.00	0.00	0.00
Georgia	1.47	4.97	5.55	0.00	5.27
Florida	0.45	1.53	0.00	0.00	0.00
Alabama	1.89	6.37	7.11	0.00	6.76
Delta States:					
Mississippi	0.21	0.71	0.79	0.00	0.75
Arkansas	0.24	0.80	0.90	0.00	0.85
Louisiana	0.21	0.71	0.79	0.83	0.75
Southern Plains:					
Oklahoma	0.00	4.75	0.00	0.00	5.04
Texas	0.73	2.45	2.74	2.87	2.60
Mountain:					
Montana	0.74	2.50	2.80	0.00	2.66
Idaho	0.47	1.59	1.77	0.00	1.68
Wyoming	0.32	1.07	1.19	0.00	1.13
Colorado	0.22	0.00	0.85	0.00	0.00
New Mexico	0.17	0.00	0.00	0.69	0.00
Arizona	0.00	0.00	0.00	0.00	0.00
Utah	0.84	2.85	3.18	0.00	0.00
Nevada	0.39	1.33	1.49	0.00	1.42
Pacific:					
Washington	2.66	0.00	0.00	0.00	0.00
Oregon	2.44	8.23	0.00	0.00	0.00
California	0.25	0.85	0.00	0.00	0.00
Alaska	1.42	4.79	5.35	0.00	0.00
Hawaii	0.05	0.00	0.20	0.00	0.00

Table 18--Total cost of energy for onfarm pumping of irrigation water, 1974 ^{1/}

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG	Total
<u>1,000 dollars</u>						
<u>Groundwater</u>						
Northeast:	169	463	2,150	0	204	2,986
Maine	0	0	0	0	0	0
Massachusetts	1	0	9	0	1	11
New Hampshire	0	0	0	0	0	0
Vermont	0	0	0	0	0	0
Rhode Island	0	0	0	0	0	0
Connecticut	1	0	9	0	1	11
New York	19	100	208	0	0	328
New Jersey	119	246	1,674	0	125	2,164
Pennsylvania	2	3	23	0	0	29
Delaware	20	73	178	0	48	319
Maryland	8	40	48	0	28	124
Lake States:	2,023	771	364	0	143	3,302
Michigan	505	122	72	0	0	699
Wisconsin	976	240	137	0	0	1,353
Minnesota	542	410	155	0	143	1,250
Corn Belt:	274	438	1,335	4	722	2,774
Ohio	32	18	86	0	16	152
Indiana	25	51	239	2	157	474
Illinois	54	117	492	0	165	827
Iowa	48	112	210	0	20	390
Missouri	115	140	310	3	364	931
Northern Plains:	21,748	31,857	2,687	19,163	30,305	105,760
North Dakota	331	112	68	0	18	529
South Dakota	257	271	95	0	344	968
Nebraska	18,524	28,608	1,612	4,626	25,534	78,903
Kansas	2,635	2,866	911	14,538	4,410	25,360
Appalachian:	46	33	101	1	8	188
Virginia	2	7	45	0	4	58
West Virginia	0	0	0	0	0	0
North Carolina	34	3	4	0	0	41
Kentucky	0	1	7	0	0	8
Tennessee	10	22	44	1	5	81
Southeast:	3,166	4,710	2,792	1	3,744	14,413
South Carolina	176	69	0	0	0	245
Georgia	40	537	900	0	296	1,772
Florida	2,944	4,076	1,851	0	3,445	12,315
Alabama	7	29	42	1	3	82
Delta States:	2,725	5,076	6,684	510	7,125	22,119
Mississippi	479	2,041	538	0	462	3,520
Arkansas	1,693	1,045	4,556	186	6,339	12,818
Louisiana	554	1,990	1,590	324	324	4,782
Southern Plains:	30,277	3,022	3,811	49,758	12,588	99,456
Oklahoma	2,380	1,247	1,003	4,457	3,120	12,208
Texas	27,897	1,775	2,808	45,301	9,468	87,248
Mountain:	96,675	9,942	7,343	26,189	6,443	146,599
Montana	583	207	330	5	20	1,144
Idaho	23,726	480	1,560	305	589	26,660
Wyoming	4,433	562	117	92	165	5,368
Colorado	8,754	424	138	3,525	534	13,375
New Mexico	7,978	3,378	3,678	11,371	4,793	31,197
Arizona	41,639	0	0	10,824	0	52,463
Utah	3,976	1,746	1,274	68	146	7,210
Nevada	5,586	3,145	246	0	197	9,173
Pacific:	98,565	127	0	872	0	99,564
Washington	4,746	0	0	0	0	4,746
Oregon	5,251	127	0	0	0	5,379
California	88,568	0	0	872	0	89,440
Alaska	11	1	7	0	0	19
Hawaii	22,253	0	433	0	0	22,686
Total groundwater	463,398	56,440	27,706	98,326	61,283	707,153

^{1/} Totals may not add due to rounding.

Continued

Table 18--Total cost of energy for onfarm pumping of irrigation water, 1974^{1/}--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG	Total
<u>Surface water</u>			<u>1,000 dollars</u>			
Northeast:						
Maine	98	280	1,127	0	119	1,624
Massachusetts	3	11	37	0	0	50
New Hampshire	17	0	202	0	28	247
Vermont	3	10	33	0	0	45
Rhode Island	1	3	11	0	0	15
Connecticut	1	5	16	0	0	23
New York	3	13	43	0	0	60
New Jersey	15	76	159	0	0	250
Pennsylvania	26	54	367	0	27	474
Delaware	10	19	129	0	2	159
Maryland	5	20	47	0	13	85
	14	69	83	0	48	215
Lake States:	962	298	152	0	36	1,448
Michigan	363	88	52	0	0	502
Wisconsin	458	108	62	0	0	627
Minnesota	142	102	39	0	36	319
Corn Belt:	84	90	304	0	168	645
Ohio	41	23	106	0	19	190
Indiana	12	23	109	0	76	221
Illinois	0	0	0	0	0	0
Iowa	7	16	29	0	3	55
Missouri	23	28	59	0	69	179
Northern Plains:	916	774	792	0	2,726	5,208
North Dakota	37	12	7	0	2	58
South Dakota	627	661	233	0	839	2,360
Nebraska	219	0	552	0	1,773	2,543
Kansas	33	101	0	0	111	246
Appalachian:	483	127	571	0	34	1,215
Virginia	15	45	283	0	22	366
West Virginia	1	4	27	0	0	32
North Carolina	454	33	55	0	0	543
Kentucky	0	17	152	0	0	169
Tennessee	12	27	53	0	12	104
Southeast:	677	2,315	623	0	193	3,806
South Carolina	168	63	0	0	0	232
Georgia	26	337	566	0	186	1,115
Florida	472	1,874	0	0	0	2,345
Alabama	11	39	57	0	7	115
Delta States:	345	767	847	72	734	2,765
Mississippi	42	170	45	0	39	296
Arkansas	174	154	448	0	623	1,399
Louisiana	129	443	354	72	72	1,070
Southern Plains:	3,192	385	205	2,680	1,839	8,302
Oklahoma	0	126	0	0	630	756
Texas	3,192	259	205	2,680	1,209	7,546
Mountain:	5,310	1,107	934	3	123	7,476
Montana	2,272	529	248	0	65	3,114
Idaho	1,563	32	205	0	39	1,839
Wyoming	166	20	8	0	15	209
Colorado	48	0	1	0	0	49
New Mexico	103	0	0	3	0	106
Arizona	0	0	0	0	0	0
Utah	1,018	447	446	0	0	1,931
Nevada	139	79	6	0	4	229
Pacific:	41,534	361	0	0	0	41,895
Washington	25,337	0	0	0	0	25,337
Oregon	14,981	335	0	0	0	15,317
California	1,670	26	0	0	0	1,696
Alaska	2	0	2	0	0	4
Hawaii	7	0	0	0	0	7
Total surface water	54,778	6,514	5,556	2,755	5,972	75,576
Total groundwater and surface water	518,176	62,954	33,262	101,081	67,255	782,729

^{1/} Totals may not add due to rounding.

Table 19--Cost per acre for onfarm pumping of irrigation water, 1974

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>Groundwater</u>	<u>Dollars</u>				
Northeast:					
Maine	12.25	14.11	26.28	0.00	23.74
Massachusetts	0.00	0.00	0.00	0.00	0.00
New Hampshire	5.69	0.00	11.95	0.00	11.71
Vermont	0.00	0.00	0.00	0.00	0.00
Rhode Island	0.00	0.00	0.00	0.00	0.00
Connecticut	5.72	0.00	12.02	0.00	10.61
New York	6.49	8.33	13.90	0.00	0.00
New Jersey	15.80	21.85	31.89	0.00	33.36
Pennsylvania	8.18	9.97	16.18	0.00	16.86
Delaware	9.78	12.24	19.74	0.00	16.11
Maryland	9.98	12.49	20.16	0.00	17.48
Lake States:	11.12	15.35	25.49	0.00	21.82
Michigan	11.26	14.51	25.72	0.00	0.00
Wisconsin	10.61	13.90	23.85	0.00	0.00
Minnesota	12.03	16.65	27.03	0.00	21.82
Corn Belt:	5.40	7.73	14.41	2.63	10.00
Ohio	7.62	10.27	17.84	0.00	13.38
Indiana	13.41	19.07	31.38	5.88	24.32
Illinois	8.93	13.03	20.07	0.00	15.68
Iowa	4.77	6.42	10.49	0.00	8.09
Missouri	4.02	5.42	8.67	1.77	7.06
Northern Plains:	15.20	21.40	38.68	7.89	26.42
North Dakota	13.22	21.19	34.39	0.00	26.86
South Dakota	15.32	23.34	37.09	0.00	28.61
Nebraska	15.03	21.04	37.93	7.26	26.12
Kansas	16.80	25.59	40.67	8.11	28.12
Appalachian:	7.53	10.57	14.58	3.54	13.98
Virginia	5.81	8.04	13.32	0.00	11.90
West Virginia	0.00	0.00	0.00	0.00	0.00
North Carolina	7.54	11.85	17.29	0.00	0.00
Kentucky	0.00	5.55	8.78	0.00	0.00
Tennessee	8.07	12.08	18.14	3.54	16.06
Southeast:	9.03	12.66	20.90	2.73	18.33
South Carolina	16.90	26.56	0.00	0.00	0.00
Georgia	12.41	17.65	26.15	0.00	24.70
Florida	8.76	12.13	19.28	0.00	17.94
Alabama	6.21	9.06	13.08	2.73	12.35
Delta States:	7.24	12.33	15.17	3.69	11.88
Mississippi	10.59	15.05	23.79	0.00	20.44
Arkansas	6.04	7.46	13.02	2.65	11.32
Louisiana	10.86	14.63	23.39	4.77	19.06
Southern Plains:	19.27	26.45	40.60	8.47	33.53
Oklahoma	23.34	30.57	49.16	10.24	38.24
Texas	18.99	24.16	38.22	8.33	32.22
Mountain:	30.60	60.35	78.86	21.95	71.71
Montana	20.52	36.96	63.42	12.39	49.54
Idaho	29.70	56.53	91.75	17.92	69.29
Wyoming	29.80	40.14	66.96	13.08	47.08
Colorado	9.84	13.25	21.18	4.32	16.69
New Mexico	48.86	72.41	118.26	23.59	88.06
Arizona	67.93	0.00	0.00	32.80	0.00
Utah	33.13	72.74	113.76	21.33	91.00
Nevada	42.13	92.49	144.63	0.00	115.70
Pacific:	21.65	67.75	0.00	10.26	0.00
Washington	23.73	0.00	0.00	0.00	0.00
Oregon	28.21	67.75	0.00	0.00	0.00
California	21.26	0.00	0.00	10.26	0.00
Alaska	5.01	6.44	9.67	0.00	0.00
Hawaii	301.05	0.00	780.36	0.00	0.00

Continued

Table 19--Cost per acre for onfarm pumping of irrigation water, 1974--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>Surface water</u>			<u>Dollars</u>		
Northeast:					
Maine	5.86	8.06	11.93	0.00	12.44
Massachusetts	4.18	5.37	8.79	0.00	0.00
New Hampshire	4.04	0.00	8.48	0.00	7.49
Vermont	4.35	5.58	9.14	0.00	0.00
Rhode Island	4.35	5.58	9.14	0.00	0.00
Connecticut	4.35	5.58	9.14	0.00	0.00
New York	5.17	6.64	11.08	0.00	0.00
New Jersey	8.46	11.70	17.08	0.00	17.86
Pennsylvania	5.44	6.63	10.76	0.00	11.21
Delaware	8.78	10.99	17.73	0.00	14.47
Maryland	8.70	10.89	17.57	0.00	15.24
Lake States:	8.45	9.57	17.12	0.00	9.04
Michigan	8.52	10.98	19.46	0.00	0.00
Wisconsin	10.39	13.02	22.33	0.00	0.00
Minnesota	5.21	6.90	11.19	0.00	9.04
Corn Belt:	4.03	5.01	10.05	0.00	6.19
Ohio	6.03	7.77	13.51	0.00	10.13
Indiana	8.58	11.56	19.20	0.00	14.88
Illinois	0.00	0.00	0.00	0.00	0.00
Iowa	4.70	6.06	9.89	0.00	7.63
Missouri	2.09	2.69	4.30	0.00	3.50
Northern Plains:	6.48	14.26	9.59	0.00	6.72
North Dakota	2.17	3.31	5.37	0.00	4.19
South Dakota	17.73	27.01	42.92	0.00	33.10
Nebraska	2.88	0.00	7.27	0.00	5.01
Kansas	2.54	3.87	0.00	0.00	4.25
Appalachian:	4.91	6.80	10.35	0.00	11.40
Virginia	5.99	7.93	13.15	0.00	11.74
West Virginia	5.67	7.50	12.43	0.00	0.00
North Carolina	4.86	6.43	10.66	0.00	0.00
Kentucky	0.00	4.40	6.96	0.00	0.00
Tennessee	5.68	8.13	12.21	0.00	10.81
Southeast:	2.89	3.44	11.27	0.00	4.12
South Carolina	7.97	11.98	0.00	0.00	0.00
Georgia	5.78	7.87	11.65	0.00	11.01
Florida	2.29	3.03	0.00	0.00	0.00
Alabama	4.23	5.91	8.53	0.00	8.05
Delta States:	2.70	3.28	5.65	1.08	5.08
Mississippi	2.23	3.03	4.80	0.00	4.12
Arkansas	2.94	3.47	6.05	0.00	5.26
Louisiana	2.58	3.33	5.32	1.08	4.34
Southern Plains:	7.33	10.41	14.12	3.08	13.78
Oklahoma	0.00	15.83	0.00	0.00	19.80
Texas	7.33	8.92	14.12	3.08	11.90
Mountain:	6.91	17.42	27.01	1.23	14.10
Montana	9.38	16.90	28.99	0.00	22.65
Idaho	5.50	10.47	17.00	0.00	12.84
Wyoming	3.90	5.03	8.39	0.00	5.90
Colorado	1.64	0.00	3.37	0.00	0.00
New Mexico	2.54	0.00	0.00	1.23	0.00
Arizona	0.00	0.00	0.00	0.00	0.00
Utah	11.12	24.42	38.19	0.00	0.00
Nevada	5.21	11.43	17.88	0.00	14.30
Pacific:	20.86	38.97	0.00	0.00	0.00
Washington	23.73	0.00	0.00	0.00	0.00
Oregon	26.30	58.30	0.00	0.00	0.00
California	4.68	7.12	0.00	0.00	0.00
Alaska	3.23	0.00	6.42	0.00	0.00
Hawaii	24.04	0.00	0.00	0.00	0.00

Table 20--Cost per acre-foot for onfarm pumping of irrigation water, 1974

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
<u>Groundwater</u>			<u>Dollars</u>		
Northeast:					
Maine	17.79	20.49	38.17	0.00	34.49
Massachusetts	0.00	0.00	0.00	0.00	0.00
New Hampshire	13.64	0.00	28.65	0.00	28.09
Vermont	0.00	0.00	0.00	0.00	0.00
Rhode Island	0.00	0.00	0.00	0.00	0.00
Connecticut	0.00	0.00	28.83	0.00	25.44
New York	13.72	19.98	33.32	0.00	0.00
New Jersey	15.55	26.23	38.29	0.00	40.05
Pennsylvania	18.97	23.91	38.81	0.00	40.42
Delaware	19.62	20.99	33.86	0.00	27.64
Maryland	16.77	16.66	26.88	0.00	23.31
Lake States:	13.31				
Michigan	14.46	19.95	33.14	0.00	29.09
Wisconsin	16.89	21.76	38.57	0.00	0.00
Minnesota	12.74	16.69	28.63	0.00	0.00
Ohio	16.04	22.21	36.04	0.00	29.09
Indiana	9.50	13.59	25.34	4.63	17.59
Illinois	15.24	20.54	35.68	0.00	26.76
Iowa	16.10	22.89	37.68	7.06	29.20
Missouri	13.39	19.54	30.08	0.00	23.50
Kansas	8.17	11.01	17.99	0.00	13.87
Corn Belt:	8.05	10.84	17.33	3.53	14.13
North Dakota	8.88	12.50	22.60	4.61	15.44
South Dakota	13.22	21.19	34.39	0.00	26.86
Nebraska	12.26	18.67	29.67	0.00	22.89
Tennessee	8.20	11.48	20.69	3.96	14.25
Kansas	11.20	17.06	27.11	5.41	18.75
Appalachian:	14.50	20.36	28.07	6.08	26.91
Virginia	11.62	16.09	26.65	0.00	23.79
West Virginia	0.00	0.00	0.00	0.00	0.00
North Carolina	15.08	23.70	34.59	0.00	0.00
Kentucky	0.00	16.68	26.35	0.00	0.00
Tennessee	13.84	20.72	31.11	6.08	27.55
Southeast:	12.31	17.26	28.50	8.18	25.00
South Carolina	25.33	39.82	0.00	0.00	0.00
Georgia	21.29	30.28	44.85	0.00	42.36
Florida	11.68	16.17	25.70	0.00	23.92
Alabama	18.65	27.21	39.28	8.18	37.10
Delta States:	4.01	6.84	8.41	2.05	6.59
Mississippi	6.69	9.51	15.03	0.00	12.91
Arkansas	3.30	4.07	7.10	1.45	6.18
Louisiana	5.92	7.98	12.76	2.60	10.40
Southern Plains:	12.97	17.80	27.33	5.70	21.57
Oklahoma	17.51	22.93	36.88	7.68	28.68
Texas	12.66	16.11	25.48	5.56	21.48
Mountain:	13.16	25.95	33.92	9.44	30.84
Montana	10.26	18.48	31.71	6.19	24.77
Idaho	11.88	22.61	36.70	7.17	27.72
Wyoming	16.26	21.90	36.53	7.13	25.69
Colorado	9.06	12.24	19.56	3.99	15.41
New Mexico	19.54	28.96	47.30	9.44	35.23
Arizona	16.98	0.00	0.00	8.20	0.00
Utah	11.04	24.25	37.92	7.11	30.33
Nevada	14.04	30.83	48.21	0.00	38.57
Pacific:	7.50	23.91	0.00	3.23	0.00
Washington	6.24	0.00	0.00	0.00	0.00
Oregon	0.96	23.91	0.00	0.00	0.00
California	6.70	0.00	0.00	3.23	0.00
Alaska	20.04	25.76	38.68	0.00	0.00
Hawaii	50.18	0.00	100.06	0.00	0.00

Continued

Table 20--Cost per acre-foot for onfarm pumping of irrigation water, 1974--continued

State and region	Electricity	Diesel	Gasoline	Natural gas	LPG
Surface water			<u>Dollars</u>		
Northeast:					
Maine	10.86	14.94	22.12	0.00	23.05
Massachusetts	10.03	12.88	21.08	0.00	0.00
New Hampshire	9.68	0.00	20.35	0.00	17.95
Vermont	10.43	13.39	21.91	0.00	0.00
Rhode Island	10.43	13.39	21.91	0.00	0.00
Connecticut	10.43	13.39	21.91	0.00	0.00
New York	12.40	15.92	26.56	0.00	0.00
New Jersey	10.16	14.05	20.50	0.00	21.45
Pennsylvania	13.05	15.90	25.81	0.00	26.88
Delaware	15.06	18.85	30.41	0.00	24.82
Maryland	11.60	14.52	23.42	0.00	20.32
Lake States:	11.25	12.74	22.80	0.00	12.05
Michigan	12.77	16.46	29.17	0.00	0.00
Wisconsin	12.47	15.62	26.81	0.00	0.00
Minnesota	6.94	9.20	14.92	0.00	12.05
Corn Belt:	7.25	9.01	18.08	0.00	11.13
Ohio	12.07	15.55	27.02	0.00	20.26
Indiana	10.29	14.00	23.05	0.00	17.86
Illinois	0.00	0.00	0.00	0.00	0.00
Iowa	8.06	10.39	16.97	0.00	13.09
Missouri	4.17	5.38	8.60	0.00	7.01
Northern Plains:	3.82	8.41	5.65	0.00	3.96
North Dakota	2.17	3.31	5.37	0.00	4.19
South Dakota	14.18	21.60	34.33	0.00	26.48
Nebraska	1.57	0.00	3.97	0.00	2.73
Kansas	1.69	2.58	0.00	0.00	2.83
Appalachian:	10.18	14.12	21.48	0.00	23.65
Virginia	11.98	15.87	26.29	0.00	23.47
West Virginia	9.72	12.87	21.33	0.00	0.00
North Carolina	9.71	12.86	21.31	0.00	0.00
Kentucky	0.00	13.22	20.89	0.00	0.00
Tennessee	9.74	13.95	20.94	0.00	18.54
Southeast:	4.01	4.77	15.62	0.00	15.06
South Carolina	11.77	17.69	0.00	0.00	0.00
Georgia	9.92	13.49	19.99	0.00	18.88
Florida	3.05	4.05	0.00	0.00	0.00
Alabama	12.71	17.74	25.61	0.00	24.18
Delta States:	1.50	1.82	3.14	0.59	2.82
Mississippi	1.41	1.92	3.03	0.00	2.60
Arkansas	1.60	1.89	3.30	0.00	2.87
Louisiana	1.41	1.82	2.90	0.59	2.37
Southern Plains:	4.89	6.96	9.41	2.05	9.22
Oklahoma	0.00	11.87	0.00	0.00	14.85
Texas	4.89	5.95	9.41	2.05	7.93
Mountain:	2.72	6.85	10.62	0.49	5.54
Montana	3.48	6.26	10.74	0.00	8.39
Idaho	2.20	4.19	6.80	0.00	5.13
Wyoming	2.13	2.74	4.58	0.00	3.22
Colorado	1.51	0.00	3.11	0.00	0.00
New Mexico	1.02	0.00	0.00	0.49	0.00
Arizona	0.00	0.00	0.00	0.00	0.00
Utah	3.71	8.14	12.73	0.00	0.00
Nevada	1.74	3.81	5.96	0.00	4.77
Pacific:	6.03	10.47	0.00	0.00	0.00
Washington	6.24	0.00	0.00	0.00	0.00
Oregon	9.29	20.58	0.00	0.00	0.00
California	1.47	1.01	0.00	0.00	0.00
Alaska	12.92	0.00	25.61	0.00	0.00
Hawaii	4.06	0.00	0.00	0.00	0.00

Table 21--Prices used for energy cost calculations^{1/}

State and region	Electricity per kWh	Diesel per gallon	Gasoline per gallon	LPG per gallon
<u>Dollars</u>				
Northeast:				
Maine	0.025	0.39	0.51	0.36
Massachusetts	0.025	0.39	0.51	0.36
New Hampshire	0.025	0.39	0.51	0.36
Vermont	0.025	0.39	0.51	0.36
Rhode Island	0.025	0.39	0.51	0.36
Connecticut	0.025	0.39	0.51	0.36
New York	0.025	0.39	0.52	0.36
New Jersey	0.025	0.42	0.49	0.41
Pennsylvania	0.025	0.37	0.48	0.40
Delaware	0.025	0.38	0.49	0.32
Maryland	0.025	0.38	0.49	0.34
Lake States:				
Michigan	0.023	0.36	0.51	0.31
Wisconsin	0.023	0.35	0.48	0.32
Minnesota	0.023	0.37	0.48	0.31
Corn Belt:				
Ohio	0.023	0.36	0.50	0.30
Indiana	0.023	0.38	0.50	0.31
Illinois	0.023	0.39	0.48	0.30
Iowa	0.023	0.36	0.47	0.29
Missouri	0.023	0.36	0.46	0.30
Northern Plains:				
North Dakota	0.020	0.37	0.48	0.30
South Dakota	0.020	0.37	0.47	0.29
Nebraska	0.020	0.34	0.49	0.27
Kansas	0.020	0.37	0.47	0.26
Appalachian:				
Virginia	0.023	0.37	0.49	0.35
West Virginia	0.023	0.37	0.49	0.35
North Carolina	0.023	0.37	0.49	0.31
Kentucky	0.023	0.38	0.48	0.33
Tennessee	0.023	0.40	0.48	0.34
Southeast:				
South Carolina	0.023	0.42	0.47	0.35
Georgia	0.023	0.38	0.45	0.34
Florida	0.023	0.37	0.47	0.35
Alabama	0.023	0.39	0.45	0.34
Delta States:				
Mississippi	0.023	0.38	0.48	0.33
Arkansas	0.023	0.33	0.46	0.32
Louisiana	0.023	0.36	0.46	0.30
Southern Plains:				
Oklahoma	0.023	0.35	0.45	0.28
Texas	0.023	0.34	0.43	0.29
Mountain:				
Montana	0.016	0.35	0.48	0.30
Idaho	0.016	0.37	0.48	0.29
Wyoming	0.023	0.36	0.48	0.27
Colorado	0.023	0.36	0.46	0.29
New Mexico	0.020	0.36	0.47	0.28
Arizona	0.020	0.37	0.48	0.30
Utah	0.015	0.40	0.50	0.32
Nevada	0.015	0.40	0.50	0.32
Pacific:				
Washington	0.008	0.35	0.49	0.30
Oregon	0.013	0.35	0.46	0.30
California	0.020	0.37	0.48	0.30
Alaska	0.032	0.30	0.60	0.00
Hawaii	0.030	0.00	0.60	0.00

^{1/} Natural gas is assumed to be 75¢ per MCF.Source: Agricultural Prices, Stat. Rptg. Serv., U.S. Dept. Agr., Washington, D.C., 1974.

APPENDIX I

PROCEDURE

The method used to estimate energy used for irrigation was to determine how much water was pumped and then how much effort or work was required to pump and distribute that amount of water. The next step was to determine how much energy was needed to perform that amount of work. This was accomplished separately for groundwater and surface water.

The quantity of water pumped in each State was determined as follows:

$$AF_i = (AI_i) (AFA_i) \quad i = 1, \dots, 50 \quad (1)$$

where

AF_i = acre-feet of water used from groundwater (pumped surface water) sources in i th State,

AI_i = acres irrigated from groundwater (pumped surface water) in i th State, and

AFA_i = average annual acre-feet applied per acre in i th State.

The work required to pump the water to ground level is measured in psi. The psi is determined by dividing the feet of lift by 2.31. The total work (ac. ft. psi) required to get the groundwater used for irrigation in each State to the surface is determined by:

$$TPW_i = (AF_i) (PW_i) \quad i = 1, \dots, 50 \quad (2)$$

where

TPW_i = total work required to get water to ground level in the i th State,

AF_i = equation (1), and

PW_i = PSI required to get water to ground level for the average feet of lift in i th State.

Work required to distribute groundwater (pumped surface water) in each State is estimated as follows:

$$TPD_i = AF_i \sum_{j=1}^4 (DP_{ij}) (PD_i) \quad (3)$$

$i = 1, \dots, 50$ States

$j = 1, \dots, 4$ types of irrigation systems

where

TPD_i = total work required to distribute groundwater (pumped surface water) in the i th State,

AF_i = equation (1),

DP_{ij} = percentage of acres irrigated in i th State by j th system, and

PD_j = pressure required to operate j th system.

The sum of equation (2) plus equation (3) is the total work (ac. ft. psi) to irrigate with groundwater (pumped surface water) in a State. The amount of energy consumed to pump and distribute the irrigation water by each energy source is estimated as follows:

$$ER_{ij} = [TPW_i + TPD_i] [(ET_{ij}) (ETR_j)] \quad (4)$$

$$ER_{ij} = [TPW_i + TPD_i] [(ET_{ij}) (ETR_j)]$$

$i = 1, \dots 50$ States

$j = 1, \dots 5$ types of power units

where

ER_{ij} = energy required in i th State by the j th power unit,

TPW_i and TPD_i = equations (2) and (3),

ET_{ij} = proportion of acres irrigated in i th State with j th power units,

ETR_j = amount of fuel required to pump one acre-foot of water at one (1) PSI with j th power unit.

Equation (4) assumes that the various distribution systems use equal proportions of the types of power units in the State, i.e., sprinkler systems power units are distributed proportionally the same as gravity flow power units.

APPENDIX II

IRRIGATION SPECIALISTS CONTACTED

Alabama: Charles B. Ogburn, Auburn Univ., Auburn

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Connecticut: Ralph P. Prince, Univ. Connecticut, Storrs

Delaware: Thomas H. Williams, Univ. Delaware, Newark

Florida: Dalton S. Harrison, Univ. Florida, Gainesville

Georgia: Robert E. Skinner, Univ. Georgia, Athens

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Idaho: Dorrell C. Larsen, Univ. Idaho, Boise; Richard Schermerhorn, Univ. Idaho, Moscow

Illinois: Carrol J.W. Drabios, Univ. Illinois, Urbana

Indiana: Jerry V. Mannering, Purdue Univ., West Lafayette

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Maryland: Lewis E. Carr, Univ. Maryland, Salisbury

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Michigan: William J. Walsh, Water Resources Planner, Lansing

Minnesota: John L. McVey, Mississippi State Univ., State College

Missouri: Jim Steichen, Univ. Missouri, Columbia

Montana: J.E. Acord, Water Resources Engineer, Helena; V.K. Haderlie, SCS, State Conservationist, Bozeman

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Nevada: Clare N. Mahannah, Univ. Nevada, Reno

New Hampshire: B.P. Batcheider, SCS, Durham

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New Mexico: Charles M. Hohn and Robert Lansford, New Mexico State Univ., Las Cruces

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Virginia: E.B. Hale, VPI & SU, Blacksburg

Washington: Mel A. Hagood, Washington State Univ., Prosser
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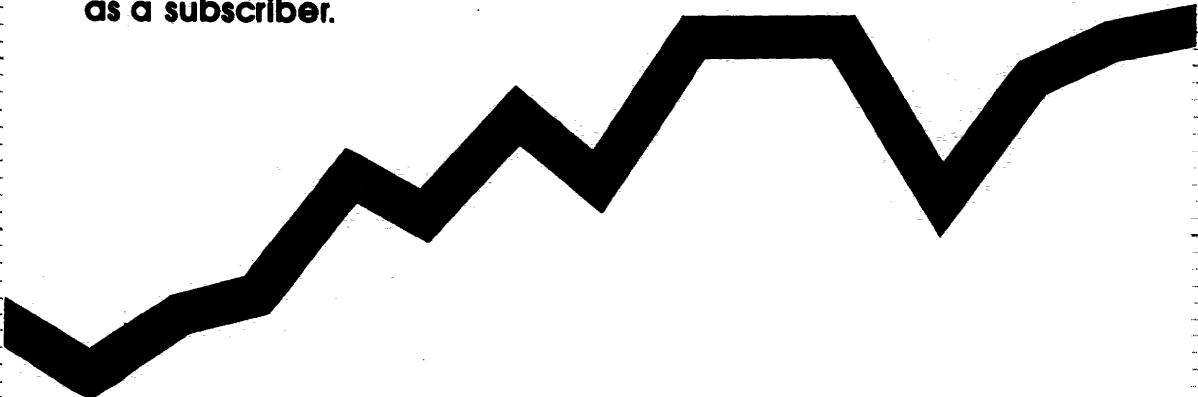
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